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# **Exposure of Forestry Applicators Using Formulations Containing 2,4-D,Dichlorprop, or Picloram in Non-Aerial Applications**

Project Completion Report

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Project Completion Report To  
United States Department of Agriculture  
Forest Service

Exposure of Forestry Applicators Using  
Formulations Containing 2,4-D, Dichlorprop,  
or Picloram in Non-Aerial Applications<sup>1</sup>

Principal Investigator: Terry L. Lavy, Ph.D.

Principal Chemist: John D. Mattice, Ph.D.

University of Arkansas  
Department of Agronomy  
Altheimer Laboratory  
501-575-3955  
Fayetteville, Arkansas

Project Coordinator: Logan A. Norris, Ph.D.  
Pacific Northwest Forest and  
Range Experiment Station  
503-754-2244  
Corvallis, Oregon

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Experiment Station, and the University of Arkansas.



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## INTRODUCTION

The use of herbicides for control of unwanted vegetation has played an important role in allowing humans to improve efficiency of food and fiber production. The herbicides 2,4-D (2,4-dichlorophenoxy)acetic acid, dichlorprop (2-(2,4-dichlorophenoxy)propionic acid), and picloram (4-amino-3,5,6-trichloropicolinic acid) have proven very beneficial for weed control in major food crops and for forest production. Chemical formulations are available which allow the forest applicator to selectively control one plant species without endangering the productivity of the desired species.

Numerous studies have been completed evaluating the selectivity, timing of application, dissipation, and economic importance of forest herbicides. Equally important are studies that quantify applicator exposure as part of the process of risk assessment. Prior to 1978 only a limited number of studies had been completed evaluating the extent of man's exposure occurring during the application process. Sauerhoff et al., 1977 had shown that oral doses of phenoxy herbicides to man resulted in the rapid and nearly quantitative urinary excretion of 2,4-D. Since that time it has been shown that inhaled or dermally absorbed doses are also readily excreted in the urine of man and other mammals. Thus, amount of 2,4-D in urine is an excellent tool for monitoring human exposure to 2,4-D. Since dichlorprop is closely related chemically, it was anticipated that urine could also be used for monitoring doses acquired during application of this compound. At the initiation of this project no quantifiable data on picloram excretion from humans had been published.

As discussions continue regarding the possibility of increased health effects among forest pesticide applicators, it is important to obtain well-quantified replicated research information. It is important that data from strategically designed, carefully conducted research projects on applicator exposure be available to allow scientists, administrators, and regulators to make correct decisions with regard to use of herbicides containing 2,4-D, dichlorprop, or picloram.

Following evaluation of the 1978 Arkansas 2,4,5-T applicator exposure study (Lavy, 1978; Lavy et al., 1980) research was initiated in the Pacific Northwest to collect information on the exposure levels of helicopter crew members applying 2,4-D in the forest (Lavy, 1980; Lavy et al., 1982). Results from this study revealed that worker exposure was quite low. Since data from the 2,4,5-T study indicated that ground application crews were more highly exposed than helicopter crews, the U.S. Forest Service was interested in obtaining additional information on exposure of ground-application crews to 2,4-D, dichlorprop, and picloram.

These studies also indicated exposure by inhalation was small compared to the dermally absorbed dose. The studies also showed a poor correlation between herbicide levels on patches and that excreted in urine (Lavy, 1978; Lavy, 1980). Thus, only the absorbed dose as determined by urine analysis will be measured in the present study.

The objective of this study was to determine the dosage received by ground applicators of 2,4-D, dichlorprop, and picloram using conventional application practices compared to the amount they received



when special safety procedures were followed which included wearing new leather gloves and new boots. Four different application methods were evaluated.

In conjunction with data from other studies on toxicology and pharmacokinetics, results of these field studies can be used to interpret the toxicological significance of exposure.

#### MATERIALS AND METHODS

Four different groups of 20 workers each participated in the study (Table 1). The 20 workers in Group A applied Weedone 170® (50% 2,4-D and 50% dichlorprop) as a foliar spray using a backpack applicator; workers in Group B applied Tordon 101-R® (80% 2,4-D and 20% picloram) using an injection bar; workers in Group C applied Tordon 101-R® using a Hypohatchet® hereafter referred to as hypohatchet; and workers in Group D used the hack and squirt method for applying Tordon 101-R®.

Table 1. Application methods and herbicides applied.

| Worker Group | Application Method                | Herbicides Applied                    |
|--------------|-----------------------------------|---------------------------------------|
| A            | Backpack<br>(Foliar spray)        | Weedone 170®<br>(2,4-D + dichlorprop) |
| B            | Injection bar<br>(Stem contact)   | Tordon 101-R®<br>(2,4-D + picloram)   |
| C            | Hypohatchet<br>(Stem contact)     | Tordon 101-R®<br>(2,4-D + picloram)   |
| D            | Hack and squirt<br>(Stem contact) | Tordon 101-R®<br>(2,4-D + picloram)   |

Materials applied by each crew. Crews of 20 workers each were monitored to determine the absorbed dose of 2,4-D, dichlorprop, and picloram received by each of the crewmembers while applying 2,4-D. The 20-man backpack crew sprayed a forested area of 3-year-old young pine seedlings with a mixture of 24 gallons water and one gallon of Weedone 170® to remove the competition from broadleafed brush. Three additional 20-man crews applied undiluted Tordon 101-R® to the stems of several different broadleaf tree species to curtail further competition to pines. Detailed data in Table 2 show formulations for each type of application. Further details are shown on labels in Appendix V. Absorbed dose data were determined for 2,4-D, dichlorprop, and picloram.

Crew composition. Crewmembers participating in the backpack spraying portion of the tests (Group A) were employed by a private contractor hired by the Weyerhaeuser Co. All 20 injection bar crewmembers (Group B) were full-time employees of the USDA Forest Service as were 15 members of the hypohatchet crew (Group C). Fifteen

Table 2. Treatment Description for Applicator Exposure Study.

| Parameter                | Description   |
|--------------------------|---|
| <u>Group A</u>           |   |
| Type of application      | <u>Backpack</u> (foliage application)   |
| Formulation              | Weedone 170®<br>2,4-dichlorophenoxyacetic acid, butoxyethanol ester<br>(1.85 lb/gal) (ae)<br>2,4-dichlorophenoxypropionic acid, butoxyethanol ester<br>(1.85 lb/gal) acid equivalent (ae)                   |
| Manufacturer             | Union Carbide   |
| Material applied         | 1 gal Weedone 170 + 24 gal water  |
| Average application rate | 10 gal/acre (0.4 gal of conc./acre)<br>(0.74 lb 2,4-D/acre)<br>(0.74 lb dichlorprop/acre)   |
| <u>Group B</u>           |   |
| Type of application      | <u>Injection bar</u>  |
| Formulation              | Tordon 101-R®<br>Triisopropanolamine salt of<br>2,4-dichlorophenoxyacetic acid<br>(1.0 lb/gal) (ae)<br>Triisopropanolamine salt of picloram 4-amino-<br>3,5,6-trichloropicolinic acid<br>(0.27 lb/gal)(ae)  |
| Manufacturer             | Dow Chemical Co.  |
| Material applied         | Undiluted Tordon 101-R®   |
| Average application rate | 0.25 gal/acre   |
| <u>Group C</u>           |   |
| Type of application      | <u>Hypohatchet</u>  |
| Formulation              | Tordon 101-R®<br>Triisopropanolamine salt of<br>2,4-dichlorophenoxyacetic acid<br>(1.0 lb/gal) (ae)<br>Triisopropanolamine salt of picloram 4-amino-<br>3,5,6-trichloropicolinic acid<br>(0.27 lb/gal) (ae) |
| Manufacturer             | Dow Chemical Co.  |
| Material applied         | Undiluted Tordon 101-R®   |
| Average application rate | 0.5 - 2.0 gal/acre<br>(0.5 - 2.0 lb 2,4-D/acre)<br>(0.135 - 0.54 lb picloram/acre)  |

Table 2. (cont.)

| Parameter                | Description   |
|--------------------------|---|
| <u>Group D</u>           |   |
| Type of application      | <u>Hack and Squirt</u>  |
| Formulation              | Tordon 101-R®<br>Triisopropanolamine salt of<br>2,4-dichlorophenoxyacetic acid<br>(1.0 lb/gal) (ae)<br>Triisopropanolamine salt of picloram 4-amino-<br>3,5,6-trichloropicolinic acid<br>(0.27 lb/gal) (ae) |
| Manufacturer             | Dow Chemical  |
| Material applied         | Undiluted Tordon 101-R®   |
| Average application rate | 0.5 - 3.0 gal/acre<br>(0.5 - 3.0 lb 2,4-D/acre)<br>(0.135 - 0.81 lb picloram/acre)  |

of the crewmembers who participated in the hack and squirt application system (Group D) were "Older Americans" who worked on a part-time basis for the USDA Forest Service. An additional 5-man group was made up of full-time employees of Davis Forestry, Inc.; 3 of the 5 workers participated in both the hypohatchet and hack and squirt application tests. Data describing the age, race, weight, and height of the 80 workers (all male) participating in this study are presented in Table 3. Figures 1-7 show workers with their application tools for each of the four different treatments.

Treatment comparisons. To allow us to compare worker exposure under two different levels of protection each member of each crew participated in two different application tests. In the first test, designated as T<sub>1</sub>, crewmembers were instructed to dress and to apply the herbicide in the manner they were accustomed to.

A second test designated as T<sub>2</sub>, was conducted, in most cases, 6 days after T<sub>1</sub> was initiated. Participants in T<sub>2</sub> operated in a similar manner as T<sub>1</sub>, except they received special instructions intended to limit their exposure to the herbicide. T<sub>2</sub> applicators were instructed to avoid contact with the herbicide to the degree possible. In T<sub>2</sub> new leather gloves and new boots were issued to each participant one day prior to the application day. Information describing clothing to be worn, special application directions and personal hygiene measures to be followed are listed in Table 4. Earlier studies on 2,4,5-T (Lavy, 1978; Lavy et al., 1980) had suggested that due to contaminated clothing, some continued exposure of applicators occurred following the application day. As an example, backpack sprayers were

Table 3. Crew Composition Information.

| Worker No.              | Age | Race <sup>a</sup> | Weight |       | Height |
|-------------------------|-----|-------------------|--------|-------|--------|
|                         |     |                   | (lbs.) | (kg)  |        |
| Group A - Backpack      |     |                   |        |       |        |
| 1                       | 24  | C                 | 202    | 91.6  | 5' 11" |
| 2                       | 21  | C                 | 175    | 79.4  | 6' 0"  |
| 3                       | 19  | C                 | 146    | 66.2  | 5' 10" |
| 4                       | 25  | C                 | 191    | 86.6  | 6' 0"  |
| 5                       | 44  | C                 | 179    | 81.2  | 5' 9"  |
| 6                       | 21  | C                 | 152    | 68.9  | 5' 11" |
| 7                       | 19  | C                 | 174    | 78.9  | 6' 0"  |
| 8                       | 42  | C                 | 145    | 65.8  | 5' 7"  |
| 9                       | 24  | C                 | 168    | 76.2  | 6' 0"  |
| 10                      | 54  | C                 | 165    | 74.8  | 5' 6"  |
| 11                      | 26  | C                 | 191    | 86.6  | 6' 1"  |
| 12                      | 50  | C                 | 165    | 74.8  | 5' 10" |
| 13                      | 34  | C                 | 160    | 72.6  | 6' 2"  |
| 14                      | 35  | C                 | 226    | 102.5 | 5' 11" |
| 15                      | 20  | C                 | 179    | 81.2  | 6' 0"  |
| 16                      | 34  | C                 | 203    | 92.1  | 5' 11" |
| 17                      | 32  | C                 | 165    | 74.8  | 6' 0"  |
| 18                      | 36  | C                 | 140    | 63.5  | 5' 7"  |
| 19                      | 20  | C                 | 160    | 72.6  | 6' 1"  |
| 20                      | 27  | C                 | 210    | 95.3  | 6' 1"  |
| Group B - Injection Bar |     |                   |        |       |        |
| 1                       | 45  | C                 | 220    | 100.0 | 6' 0"  |
| 2                       | 38  | N                 | 135    | 61.2  | 5' 3"  |
| 3                       | 32  | C                 | 234    | 106.1 | 6' 0"  |
| 4                       | 34  | N                 | 215    | 97.5  | 6' 0"  |
| 5                       | 28  | C                 | 165    | 74.8  | 5' 10" |
| 6                       | 64  | C                 | 166    | 75.3  | 5' 10" |
| 7                       | 41  | C                 | 192    | 87.1  | 6' 1"  |
| 8                       | 60  | C                 | 135    | 61.2  | 5' 6"  |
| 9                       | 28  | C                 | 148    | 67.1  | 5' 10" |
| 10                      | 47  | C                 | 175    | 79.4  | 5' 9"  |
| 11                      | 57  | C                 | 161    | 73.0  | 5' 11" |
| 12                      | 30  | C                 | 190    | 86.2  | 5' 11" |
| 13                      | 29  | C                 | 185    | 83.9  | 5' 9"  |
| 14                      | 33  | C                 | 140    | 63.5  | 5' 5"  |
| 15                      | 57  | C                 | 180    | 81.6  | 5' 8"  |
| 16                      | 46  | C                 | 186    | 84.8  | 5' 9"  |
| 17                      | 43  | C                 | 175    | 79.4  | 5' 8"  |
| 18                      | 35  | C                 | 200    | 90.1  | 6' 2"  |
| 19                      | 29  | C                 | 172    | 78.0  | 6' 0"  |
| 20                      | 30  | C                 | 165    | 74.8  | 5' 9"  |

Table 3 (cont.)

| Worker No.                | Age | Race <sup>a</sup> | Weight |       | Height |
|---------------------------|-----|-------------------|--------|-------|--------|
|                           |     |                   | (lbs.) | (kg)  |        |
| Group C - Hypohatchet     |     |                   |        |       |        |
| 1                         | 35  | C                 | 165    | 74.8  | 6' 0"  |
| 2                         | 51  | C                 | 149    | 67.6  | 5' 8"  |
| 3                         | 42  | C                 | 164    | 74.4  | 5'10"  |
| 4                         | 31  | C                 | 171    | 77.6  | 5' 8"  |
| 5                         | 31  | C                 | 148    | 67.1  | 5' 7"  |
| 6                         | 27  | C                 | 201    | 91.2  | 5'10"  |
| 7                         | 30  | C                 | 138    | 62.6  | 5' 4"  |
| 8                         | 61  | C                 | 190    | 86.2  | 5' 9"  |
| 9                         | 39  | C                 | 165    | 74.8  | 5'10"  |
| 10                        | 30  | C                 | 185    | 83.9  | 5' 6"  |
| 11                        | 30  | C                 | 170    | 77.1  | 6' 0"  |
| 12                        | 25  | C                 | 140    | 63.6  | 5' 8"  |
| 13                        | 47  | C                 | 155    | 70.4  | 5'10"  |
| 14                        | 36  | C                 | 195    | 88.5  | 5'10"  |
| 15                        | 29  | C                 | 195    | 88.5  | 5'11"  |
| 16                        | 33  | C                 | 220    | 100.0 | 6' 0"  |
| 17                        | 23  | C                 | 160    | 72.6  | 5' 9"  |
| 18                        | 45  | C                 | 190    | 86.2  | 6' 4"  |
| 19                        | 26  | C                 | 190    | 86.2  | 5'11"  |
| 20                        | 25  | C                 | 175    | 79.4  | 6' 2"  |
| Group D - Hack and Squirt |     |                   |        |       |        |
| 1                         | 67  | N                 | 147    | 66.8  | 5' 8"  |
| 2                         | 67  | N                 | 157    | 71.3  | 6' 0"  |
| 3                         | 59  | N                 | 210    | 95.4  | 6' 0"  |
| 4                         | 64  | N                 | 191    | 86.6  | 5' 4"  |
| 5                         | 61  | N                 | 178    | 80.7  | 5'11"  |
| 6                         | 67  | N                 | 197    | 89.4  | 5' 9"  |
| 7                         | 70  | N                 | 202    | 91.6  | 6' 0"  |
| 8                         | 60  | N                 | 216    | 98.0  | 5' 9"  |
| 9                         | 31  | C                 | 185    | 83.9  | 6' 3"  |
| 10                        | 33  | N                 | 152    | 68.9  | 5' 7"  |
| 11                        | 51  | C                 | 222    | 100.9 | 5' 8"  |
| 12                        | 40  | C                 | 185    | 83.9  | 5'11"  |
| 13                        | 34  | C                 | 235    | 106.6 | 6' 7"  |
| 14                        | 31  | N                 | 175    | 79.4  | 6' 0"  |
| 15                        | 65  | N                 | 142    | 64.4  | 5' 8"  |
| 16                        | 28  | C                 | 203    | 92.1  | 6' 0"  |
| 17                        | 26  | C                 | 150    | 68.0  | 5'10"  |
| 18                        | 45  | C                 | 190    | 86.2  | 6' 4"  |
| 19                        | 26  | C                 | 190    | 86.2  | 5'11"  |
| 20                        | 25  | C                 | 175    | 79.4  | 6' 2"  |

<sup>a</sup>C = Caucasian; N = Negro.





Figure 2. All workers wore long trousers, most wore long sleeved shirts, and some wore chaps attached to their waists.

Figure 1. Backpack sprayer attached to worker.

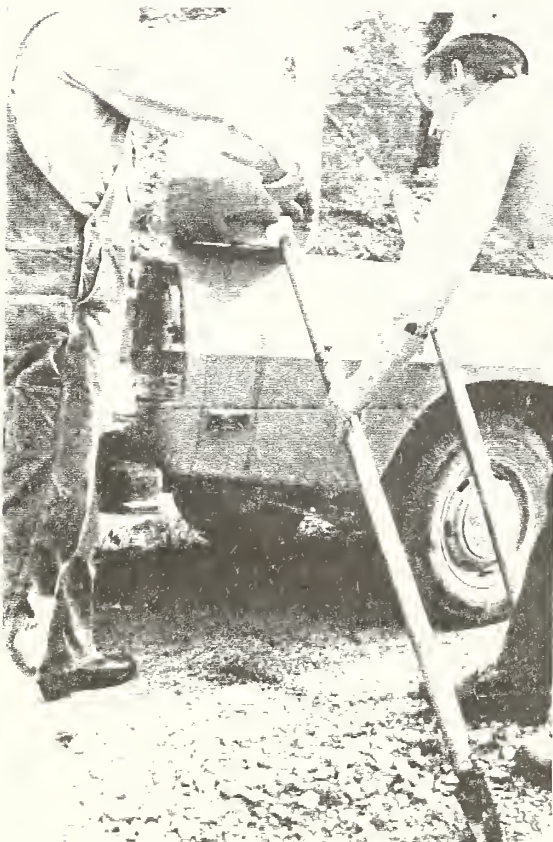


Figure 4. Tree being injected with Tordon 101-R.

Figure 3. Injection bar being filled during T<sub>2</sub>.





Figure 5. Reservoir of hypohatchet being filled during  $T_1$ .

Figure 6. Worker holding hypohatchet in  $T_2$ . Purpose of rag is to "soak up chemical that leaks."



Figure 7. Member of hack and squirt crew makes incision in tree during  $T_1$ . Notice urine container that accompanied all workers to the field.

Table 4. Worker Instructions During T<sub>1</sub> and T<sub>2</sub> Field Application.

| Instructions                       |  | T <sub>1</sub>                             | T <sub>2</sub>   |
|------------------------------------|--|--|--|
| Clothing                           |  | Whatever is normally used <sup>a</sup>     | Long sleeve shirt (cotton)<br>Long pants (cotton)<br>(freshly laundered)   |
| Boots                              |  | Most wore leather                          | Wear new boots   |
| Gloves                             |  | Variable: none, cotton,<br>leather         | Wear rubber gloves when<br>mixing or filling container   |
| Hats                               |  | Variable: all in Group D<br>wore hard hats | Wear leather gloves when<br>applying   |
| Suggested<br>means of<br>operation |  | Operate as normal                          | Wash hands before rest<br>stops (before eating,<br>using tobacco, or using<br>urine containers)<br><br>Bathe and change into<br>clean clothing as soon<br>as possible after work<br><br>Abide by supervisor's<br>instructions<br>Group A: Avoid walking<br>through sprayed areas<br>Groups B, C, and D:<br>Prevent chemical from<br>contacting skin; remove<br>concentrate from skin or<br>clothing as soon as<br>possible. For more spe-<br>cific information see<br>Appendix II. |

<sup>a</sup>Workers in T<sub>1</sub> wore long trousers and most wore long sleeved cotton shirts. Specific information for some workers is listed in Appendix III.

instructed not to walk through, but around, sprayed vegetation if possible. For T<sub>2</sub> operations all three crews using Tordon 101-R® were issued 10-gallon polyethylene storage containers with a no-drip spigot for dispensing the concentrate into the specific application tool being used.

By comparing the absorbed dose of herbicide for each worker in T<sub>1</sub> vs. T<sub>2</sub>, we can quantify the protection herbicide applicators can achieve by employing a practical set of alternatives. Some protective clothing used in previous studies was impractical due to heat in the summer and costs of the garments. Forestry field foremen were present to insure that workers performed their work duties in an acceptable manner during both tests. Instructions designed to decrease worker exposure were issued to each worker prior to the T<sub>2</sub> portion of the study.

#### Rationale For Urine Collection.

Regardless of the pathway of exposure, essentially all of the absorbed dose of 2,4-D, dichlorprop, and picloram are excreted rapidly in the urine in humans. Over 95% of the absorbed dose of 2,4-D is excreted in urine within a 5-day period (Sauerhoff, 1977). Nolan et al. (1984) have shown that in excess of 96% of an oral dose of picloram was excreted in urine within the first 24 hours.

For this study to obtain quantifiable data, considerable efforts have been made to procure the total urine output of each worker during the 12-day period. To achieve these results, the absorbed dose recieved by each crewmember was determined in T<sub>1</sub> and T<sub>2</sub> by measuring the herbicide in the total urine output for each worker beginning 1

day before the herbicide application was made and continuing for 4 days following the day of application.

The amount of herbicide excreted in the urine during the application day and the next 4 days are reported in this paper as the absorbed dose. It should be emphasized that for the phenoxy herbicides the amounts excreted and reported represent approximately 95% of the absorbed dose. For dichlorprop and picloram, the quantitative aspects of the pharmacokinetics of urinary excretion were less well defined at the initiation of this study. Since dichlorprop excretion is so similar to 2,4-D excretion, kinetics are assumed to be similar. Recent work shows that the picloram excretion in human urine is more rapid than phenoxy excretion (Nolan et al., 1984).

In further attempts to obtain quantitative exposure information from only one day of application, worker exposure was monitored during the first day of the application season. To guard against unforeseen circumstances, background herbicide levels in urine were obtained by analyzing urine collected from the participants the day prior to beginning the test. This pre-application urine sample should have been unnecessary, since the protocol specified that only workers who had no phenoxy herbicide exposure for one week prior to the test would be included in the study.

The need for total urine collection was stressed during discussions with the workers prior to the test. Every urine sample was analyzed for two of the three herbicides, and for creatinine content. A monetary incentive of \$200 per worker was provided to those who complied with the request of providing their total urine output



for the 12-day experimental period.

Location. Nine different forest locations in Arkansas, Oklahoma, and Mississippi were chosen as the application sites for these studies. Table 5 provides information on the geographic sites and monitoring dates which encompassed a 3-month period from May to August, 1982.

Weather. Climatological conditions during herbicide application are presented in Table 6. Temperature ranged from 62 to 96° F. Wind did not appear to be a significant variable. Spraying as a means of application was used only by the backpack crew.

Table 7 lists the area treated and the average amount of herbicide applied by each group of workers.

Results obtained during the T<sub>1</sub> component of the study are used to ascertain the dose of 2,4-D, dichlorprop, and picloram being absorbed by workers using their normal methods for applying these compounds in the forest. From earlier results (Lavy, 1978 and 1980) it was anticipated that some level of exposure would occur. The T<sub>2</sub> component was intended to evaluate the extent to which absorbed dose levels could be decreased if the workers were to employ a stricter set of protective measures.

During T<sub>1</sub> the workers were instructed to dress and work in their normal manner. During T<sub>2</sub> more strict guidelines were imposed. As an example, in T<sub>2</sub> workers were instructed to treat the herbicide as something "very toxic" and to immediately remove any getting on their skin or clothing. Water and soap were always provided for washing purposes during T<sub>2</sub> operations. Since data obtained in the 2,4,5-T

Table 5. Geographic Description of U.S.D.A. Forest Service Sites Used in Applicator Exposure Study.

| Worker group | Application type | Treatment no. and date             | Location and landowner <sup>b</sup> | Acres treated | Nature of treated area    | Treatment purpose                    |
|--------------|------------------|------------------------------------|-------------------------------------|---------------|---------------------------|--------------------------------------|
| A            | Backpack         | T <sub>1</sub> <sup>a</sup> 5/5/82 | Dierks, AR*                         | 62            | Gently rolling            | Control hardwood resprouts           |
|              |                  | T <sub>2</sub> 5/11/82             | Dierks, AR                          | 62            | Dense, low-growing shrubs | in a 3-yr-old loblolly plantation    |
| B            | Injection bar    | T <sub>1</sub> 5/14/82             | Rover, AR                           | 8             | Rolling, wooded           | Release pine from hardwood overstory |
|              |                  | T <sub>2</sub> 5/20/82             | Rover, AR                           | 8             |                           |                                      |
|              |                  | T <sub>1</sub> 5/14/82             | Mena, AR                            | 8             | Rolling, wooded           |                                      |
|              |                  | T <sub>2</sub> 5/20/82             | Mena, AR                            | 8             |                           |                                      |
|              |                  | T <sub>1</sub> 5/14/82             | Talihina, OK                        |               | Rolling, wooded           |                                      |
|              |                  | T <sub>2</sub> 5/26/82             | Hector, AR*                         |               | Rolling, wooded           |                                      |
| C            | Hypohatchet      | T <sub>1</sub> 5/19/82             | Mt. View, AR                        | 14            | Rolling, wooded           | Release pine from hardwood overstory |
|              |                  | T <sub>2</sub> 5/25/82             | Mt. View, AR                        | 10            |                           |                                      |
|              |                  | T <sub>1</sub> 5/26/82             | Deer, AR                            | 9             | Rolling, wooded           |                                      |
|              |                  | T <sub>2</sub> 6/1/82              | Deer, AR                            | 9             |                           |                                      |
|              |                  | T <sub>1</sub> 8/3/82              | Pansy, AR*                          | 8             | Flat, wooded              |                                      |
|              |                  | T <sub>2</sub> 8/9/82              | Pansy, AR                           | 7             |                           |                                      |
| D            | Hack and Squirt  | T <sub>1</sub> 6/3/82              | Ackerman, MS                        | 20            | Flat, wooded              | Release pine from hardwood overstory |
|              |                  | T <sub>2</sub> 6/9/82              | Ackerman, MS                        | 20            |                           |                                      |
|              |                  | T <sub>1</sub> 7/20/82             | Pansy, AR*                          | 8             | Flat, wooded              |                                      |
|              |                  | T <sub>2</sub> 7/26/82             | Pansy, AR                           | 6             |                           |                                      |

<sup>a</sup>T<sub>1</sub> = conventional methods used during application.

T<sub>2</sub> = special procedures and protective gear used.

<sup>b</sup>Locations with an \* were privately owned.

Table 6. Weather Conditions at Treatment Sites During Applicator Exposure Study.

| T <sub>1</sub>        |            |                                   |           |           | T <sub>2</sub> |            |            |          |
|-----------------------|------------|-----------------------------------|-----------|-----------|----------------|------------|------------|----------|
| <u>Group A</u>        |            |                                   |           |           |                |            |            |          |
| Location              |            | Dierks, AR                        |           |           |                | Dierks, AR |            |          |
| Date                  |            | 5/5/82                            |           |           |                | 5/11/82    |            |          |
| Time                  | 0700       | 1100                              | 1200      | 1400      | 0600           | 0900       | 1100       | 1300     |
| Temperature(°F)       | 73         | 82                                | 82        | 82        | 60             | 72         | 86         | 82       |
| Relative humidity (%) | 74         | 60                                | 57        | 52        | 80             | 73         | 62         | 50       |
| Wind direction        | --         | S                                 | S         | S         | --             | S          | S          | S        |
| Wind speed(mph)       | 0          | 5                                 | 5         | 7         | 0              | 4-6        | 5          | 4-8      |
| Sky condition         | Cldy       | Cldy                              | Cldy      | Cldy      | Full sun       | Full sun   | Full sun   | Full sun |
| <u>Group B</u>        |            |                                   |           |           |                |            |            |          |
| Location              |            | Rover, AR                         |           |           |                | Rover, AR  |            |          |
| Date                  |            | 5/14/82                           |           |           |                | 5/20/82    |            |          |
| Time                  | 0830       | 1030                              | 1230      | 1530      | 0830           | 1100       | 1500       | 1600     |
| Temperature(°F)       | 68         | 71                                | 75        | 80        | 76             | 79         | 85         | 79       |
| Relative humidity (%) | 90         | 80                                | 75        | 67        | 85             | 79         | 74         | 67       |
| Wind direction        | E          | E                                 | SE        | SE        | S              | S          | SE         | E        |
| Wind speed(mph)       | 1          | 5                                 | 11        | 3-4       | 3              | 5          | 2          | 8        |
| Sky condition         | Ptly sunny | Sun                               | Sun       | Sun       | Cldy           | Cldy       | Sun        | Sun      |
|                       |            |                                   |           |           |                |            |            |          |
| Location              |            | Talihina, OK<br>Kiamichi District |           |           |                | Hector, AR |            |          |
| Date                  |            | 5/14/82                           |           |           |                | 5/26/82    |            |          |
| Time                  | 1000       | 1200                              | 1400      | 1600      | 0900           | 1100       | 1300       |          |
| Temperature(°F)       | 70         | 74                                | 79        | 80        | 75             | 81         | 82         |          |
| Relative humidity (%) | 76         | 65                                | 63        | 57        | 81             | 68         | 65         |          |
| Wind direction        | --         | S                                 | S         | S         | --             | --         | S          |          |
| Wind speed(mph)       | 0          | 5                                 | 5-7       | 6         | 0              | 0          | 0-2        |          |
| Sky condition         | Cldy       | Ptly cldy                         | Ptly cldy | Ptly cldy | Ptly sunny     | Ptly sunny | Ptly sunny |          |

Table 6. (cont.)

| T <sub>1</sub>        |          |              |               |      | T <sub>2</sub> |              |          |          |
|-----------------------|----------|--------------|---------------|------|----------------|--------------|----------|----------|
| <u>Group B</u>        |          |              |               |      |                |              |          |          |
| Location              |          | Mena, AR     |               |      |                | Mena, AR     |          |          |
| Date                  |          | 5/14/82      |               |      |                | 5/20/82      |          |          |
| Time                  | 0900     | 1055         | 1300          | 1530 | 0945           | 1200         | 1345     | 1545     |
| Temperature(°F)       | 65       | 73           | 74            | 80   | 75             | 77           | 78       | 78       |
| Relative humidity (%) | 96       | 86           | 79            | 75   | 78             | 72           | 72       | 68       |
| Wind direction        | E        | E            | SE            | SE   | --             | --           | --       | --       |
| Wind speed(mph)       | 4        | 4-7          | 7-10          | 3-4  | 0              | 0            | 0        | 0        |
|                       |          |              | (gusts to 20) |      |                |              |          |          |
| Sky condition         | Variable | Var.         | Var.          | Var. | Cldy           | Cldy         | Cldy     | Cldy     |
| <u>Group C</u>        |          |              |               |      |                |              |          |          |
| Location              |          | Deer, AR     |               |      |                | Deer, AR     |          |          |
| Date                  |          | 5/19/82      |               |      |                | 5/25/82      |          |          |
| Time                  | 0900     | 1100         | 1300          | 1500 | 0900           | 1100         | 1300     | 1500     |
| Temperature(°F)       | 66       | 70           | 73            | 74   | 64             | 65           | 69       | 73       |
| Relative humidity (%) | 90       | 78           | 74            | 62   | 95             | 100          | 91       | 78       |
| Wind direction        | --       | --           | --            | --   | --             | --           | --       | --       |
| Wind speed(mph)       | 0        | 0            | 0             | 0    | 0              | 0            | 0        | 0        |
| Sky condition         | Cldy     | Cldy         | Cldy          | Cldy | Full sun       | Full sun     | Full sun | Full sun |
|                       |          |              |               |      |                |              |          |          |
| Location              |          | Mt. View, AR |               |      |                | Mt. View, AR |          |          |
| Date                  |          | 5/26/82      |               |      |                | 6/1/82       |          |          |
| Time                  | 0900     | 1300         | 1700          |      | 0900           | 1100         | 1400     | 1700     |
| Temperature(°F)       | 71       | 82           | 85            |      | 62             | 68           | 71       | 73       |
| Relative humidity (%) | 59       | 63           | 65            |      | 62             | 60           | 55       | 57       |
| Wind direction        |          | --           | --            |      | --             | SW           | SW       | SW       |
| Wind speed(mph)       | 0        | 0            | 0             |      | 0              | 2            | 2        | 3        |
| Sky condition         | Full sun | Full sun     | Full sun      |      | Full sun       | Full sun     | Full sun | Full sun |



Table 6. (cont.)

| T <sub>1</sub>    |              |           |           | T <sub>2</sub> |           |           |           |
|-------------------|--------------|-----------|-----------|----------------|-----------|-----------|-----------|
| <u>Group C</u>    |              |           |           |                |           |           |           |
| Location          | Pansy, AR    |           |           | Pansy, AR      |           |           |           |
| Date              | 8/3/82       |           |           | 8/9/82         |           |           |           |
| Time              | 0715         | 1100      | 1400      | 0715           | 1000      | 1200      |           |
| Temperature(°F)   | 75           | 88        | 95        | 70             | 79        | 86        |           |
| Relative humidity | 70           | 62        | 50        | 75             | 68        | 50        |           |
| Wind direction    | --           | --        | --        | --             | --        | --        |           |
| Wind speed(mph)   | 0            | 0         | 0         | 0              | 0         | 0         |           |
| Sky condition     | Full sun     | Full sun  | Full sun  | Foggy          | Sunny     | Full sun  |           |
| <u>Group D</u>    |              |           |           |                |           |           |           |
| Location          | Ackerman, MS |           |           | Ackerman, MS   |           |           |           |
| Date              | 6/3/82       |           |           | 6/9/82         |           |           |           |
| Time              | 0830         | 1100      | 1430      | 0845           | 1000      | 1145      | 1345      |
| Temperature(°F)   | 78           | 83        | 88        | 79             | 82        | 87        | 88        |
| Relative humidity | 75           | 78        | 70        | 78             | 75        | 70        | 73        |
| Wind direction    | --           | --        | --        | --             | --        | --        | --        |
| Wind speed(mph)   | 0            | 0         | 0         | 0              | 0         | 0         | 0         |
| Sky condition     | Ptly cldy    | Ptly cldy | Ptly cldy | Ptly cldy      | Ptly cldy | Ptly cldy | Ptly cldy |
|                   |              |           |           |                |           |           |           |
| Location          | Pansy, AR    |           |           | Pansy, AR      |           |           |           |
| Date              | 7/20/82      |           |           | 7/26/82        |           |           |           |
| Time              | 0800         | 1100      | 1440      | 0730           | 1100      | 1600      |           |
| Temperature(°F)   | 78           | 89        | 96        | 75             | 89        | 92        |           |
| Relative humidity | 60           | 57        | 50        | 55             | 58        | 60        |           |
| Wind direction    | --           | --        | S         | --             | --        | S         |           |
| Wind speed(mph)   | 0            | 0         | 5-10      | 0              | 0         | 5-10      |           |
| Sky condition     | Ptly cldy    | Ptly cldy | Ptly cldy | Hazy           | Sunny     | Full sun  |           |

Table 7. Acres Treated and Active Ingredient Applied.

| Group                    | Treatment      | Hours of<br>appli-<br>cation | Acreage | No. of<br>workers | Volume<br>applied per<br>worker | Herbicide            | Herbicide applied<br>acid equivalent<br>(kg/man/hour) |
|--------------------------|----------------|------------------------------|---------|-------------------|---------------------------------|----------------------|---|
| <b>A</b>                 |                |                              |         |                   |                                 |                      |   |
| Backpack                 | T <sub>1</sub> | 7.0                          | 62      | 20                | 31 gal <sup>a</sup>             | 2,4-D<br>dichlorprop | 0.15<br>0.15  |
|                          | T <sub>2</sub> | 7.0                          | 62      | 20                | 31 gal                          | 2,4-D<br>dichlorprop | 0.15<br>0.15  |
| <b>B</b>                 |                |                              |         |                   |                                 |                      |   |
| Injection<br>bar         | T <sub>1</sub> | 6.0                          | 8       | 11                | 0.5 gal                         | 2,4-D<br>picloram    | 0.04<br>0.01  |
|                          | T <sub>2</sub> | 5.75                         | 8       | 11                | 0.5 gal                         | 2,4-D<br>picloram    | 0.04<br>0.01  |
| #12-16                   | T <sub>1</sub> | 6.0                          | 8       | 5                 | 0.75-1 gal                      | 2,4-D<br>picloram    | 0.06-0.08<br>0.01-0.02                                |
|                          | T <sub>2</sub> | 4.0                          | 8       | 5                 | 0.75-1 gal                      | 2,4-D<br>picloram    | 0.09-0.11<br>0.02-0.03                                |
| #17-20                   | T <sub>1</sub> | 6.5                          | 8       | 4                 | 1.7 gal                         | 2,4-D<br>picloram    | 0.15<br>0.03  |
|                          | T <sub>2</sub> | 6.0                          | 8       | 4                 | 1.7 gal                         | 2,4-D<br>picloram    | 0.13<br>0.03  |
| <b>C</b>                 |                |                              |         |                   |                                 |                      |   |
| Hypohatchet<br>#1-7      | T <sub>1</sub> | 7.75                         | 14      | 7                 | 1.1 gal                         | 2,4-D<br>picloram    | 0.06<br>0.02  |
|                          | T <sub>2</sub> | 7.75                         | 10      | 7                 | 0.8 gal                         | 2,4-D<br>picloram    | 0.04<br>0.02  |
| #8-15                    | T <sub>1</sub> | 6.0                          | 4.5     | 8                 | 0.6 gal                         | 2,4-D<br>picloram    | 0.05<br>0.01  |
|                          | T <sub>2</sub> | 6.0                          | 4.5     | 8                 | 0.6 gal                         | 2,4-D<br>picloram    | 0.05<br>0.01  |
| #16-20                   | T <sub>1</sub> | 7.5                          | 8       | 5                 | 1.0 gal                         | 2,4-D<br>picloram    | 0.06<br>0.02  |
|                          | T <sub>2</sub> | 7.5                          | 7       | 5                 | 0.8 gal                         | 2,4-D<br>picloram    | 0.05<br>0.01  |
| <b>D</b>                 |                |                              |         |                   |                                 |                      |   |
| Hack and Squirt<br>#1-15 | T <sub>1</sub> | 5.5                          | 20      | 15                | 0.5 gal                         | 2,4-D<br>picloram    | 0.04<br>0.01  |
|                          | T <sub>2</sub> | 5.5                          | 20      | 15                | 0.5 gal                         | 2,4-D<br>picloram    | 0.04<br>0.01  |
| #16-20                   | T <sub>1</sub> | 6.5                          | 8       | 5                 | 0.8 gal                         | 2,4-D<br>picloram    | 0.06<br>0.02  |
|                          | T <sub>2</sub> | 8.5                          | 6       | 5                 | 1.0 gal                         | 2,4-D<br>picloram    | 0.05<br>0.01  |

<sup>a</sup>Group A applied a 24 gal water + 1 gal Weedone 170 mixture.

ground applicator study (Lavy, 1980) implicated 2,4,5-T contaminated clothing as a potential reservoir for re-exposing field applicators, each worker in this study was issued new leather gloves and new ankle-high leather boots one day prior to the T<sub>2</sub> application day.

Additional protective clothing (beyond the new boots and gloves) was not included because 1) most protective clothing becomes nearly unbearable due to hot, humid weather in summer months in the southern U.S.; 2) if simple, inexpensive, but functional methods for reducing exposure could be found, it is more probable they would be routinely used by forest applicators.

The following specific instructions were given to assist workers in obtaining total urine samples: Total urine collection by each worker beginning at the same time each day was a requirement of the study. The first urine void of the morning was added to the urine collected the previous day. Thus, the second urine void of the day began the new sample collection period.

A total urine collection was necessary since individual worker liquid consumption level varies widely and herbicide excretion patterns are not identical from person to person.

#### Sample Collection.

Each worker was issued an ice chest and an amber colored polyethylene 3500-ml capacity urine container for each urine collection day. Extra containers were provided in case the urine exceeded the capacity of one container. The urine was kept cool in the ice chest until it could be transferred to cold rooms at the collection sites. The urine was kept in 4 C cold rooms for 3 to 12 days before fortified samples

were prepared, urine volumes were recorded, and aliquots were placed in 150-ml polyethylene containers for transporting to the laboratory.

#### Quality Assurance.

Analytical quality assurance was obtained through (a) fortification of samples in the field, (b) fortification of samples in the lab, (c) regular injection of an analytical standard.

A series of 6 fortified urine samples were prepared at each of the on-site storage facilities for each batch of samples transported to the laboratory. These samples were interspersed, stored, and shipped with the unknown samples to ensure that the samples had not changed during the on-site storage period and transportation to the lab. At the time of analysis these fortified field samples were treated the same as the field unknowns. To ensure that sample preparation in the lab was consistent, a batch of fortified urine samples was also prepared in the lab, and these samples were interspersed with samples from the field and were analyzed as "unknown" samples. In addition, an analytical standard was injected after every fifth sample to ensure that the instruments were working properly.

#### Sample Analysis.

**Analytical Methods:** The analytical methods used to analyze for 2,4-D and dichlorprop are below. These methods are the same as those used in our previous 2,4-D study (Lavy et al., 1982) except that 2 ml of urine was analyzed instead of 1 ml. The analytical method for picloram was developed at the Alzheimer Laboratory.

**Recovery:** The percent recovery for dichlorprop is given in Table 8, for 2,4-D in Table 9, and for picloram in Table 10. Detection

Table 8. Recovery data for Urine Fortified with dichlorprop.

| Fortification <sup>a</sup><br>level (ppm) | % Recovery<br>with 95% confidence limits <sup>b</sup> |
|---|---|
| 0.000                                     | not detected  |
| 0.025                                     | 60 + 41   |
| 0.050                                     | 83 + 22   |
| 0.100                                     | 90 + 13   |
| 0.200                                     | 87 + 11   |
| 0.500                                     | 99 + 6  |
| 1.000                                     | 108 + 6   |
| 3.000                                     | 108 + 4   |

<sup>a</sup>There were 8 replications at each level. Urine from 4 different people was used with 2 samples being prepared from each batch of urine.

<sup>b</sup>The overall % recovery from 0.05 to 3.00 ppm was 96%.

Table 9. Recovery Data for Urine Fortified with 2,4-D.

| Fortification <sup>a</sup><br>level (ppm) | % Recovery<br>with 95% confidence limits <sup>b</sup> |
|---|---|
| 0.00                                      | not detected  |
| 0.04                                      | 100 + 19  |
| 0.10                                      | 100 + 5   |
| 0.20                                      | 108 + 5   |
| 0.50                                      | 100 + 3   |
| 1.00                                      | 111 + 7   |
| 2.50                                      | 105 + 7   |

<sup>a</sup>There were 14 replications at each level with 7 being prepared with one person's urine and 7 with another's.

<sup>b</sup>The percent recovery from 0.04 to 2.50 ppm was 104%.

Table 10. Recovery Data for Urine Fortified with Picloram.

| Fortification <sup>a</sup><br>level (ppm) | % Recovery<br>with 95% confidence limits <sup>b</sup> |
|---|---|
| 0.00                                      | not detected  |
| 0.02                                      | 75 + 4  |
| 0.10                                      | 76 + 3  |
| 0.40                                      | 80 + 4  |

<sup>a</sup>There were 7 replications at each level.

<sup>b</sup>The overall % recovery was 77%.

limits of 0.040 mg/L were established for dichlorprop and 2,4-D, and picloram had a detection limit of 0.010 mg/L.

#### Analytical Procedure for Urine

##### 2,4-D and dichlorprop

1. Place 2 ml of urine in a 125 mm x 20 mm culture tube equipped with a Teflon® lined screw cap.
2. Add 0.4 ml of 10N sodium hydroxide, cap, and place in an 85 C oven for 90 min.
3. Remove and allow to cool.
4. Add 0.4 ml of conc. hydrochloric acid and 4 ml of toluene.
5. Shake on a wrist-action shaker (3-4 shakes per sec) for 45 min.
6. Remove and allow the layers to separate.
7. Transfer 2 ml of the toluene layer to a clean culture tube.
8. Add 0.2 ml of boron trifluoride-butanol, cap, and place in a boiling water bath for 60 min.
9. Remove and cool.
10. Add 1.5 ml of pH 7.2 buffer (20 g of sodium bicarbonate in 1000 ml water titrated to pH 7.2 with conc. HCl) and shake for 20 min on wrist-action shaker.
11. Place an aliquot of the toluene layer in a GC vial for analysis.

##### Picloram

1. Place 10 ml of urine in a 125 mm x 20 mm culture tube equipped with a Teflon® lined screw cap.
2. Add 2 ml of concd. hydrochloric acid, cap, and place in a 95 C oven for 60 min.
3. Remove and cool in an ice bath.

4. Add 4 ml of ether and shake for 1 min.
5. Centrifuge 5 min @ 750 xg to break up emulsion.
6. Transfer ether to clean, dry culture tube.
7. Repeat steps 4 through 6 two more times, combining ether.
8. Add 3 ml of 0.1N NaOH to the ether and cap.
9. Shake for 1 min.
10. Remove and discard ether.
11. Add 0.4 ml of concd. HCl to the aqueous portion.
12. Add 5 ml of ether, cap, and shake 1 min.
13. Transfer ether to a clean, dry culture tube.
14. Repeat steps 12 and 13 combining the ether.
15. Evaporate the ether to dryness in a 35-40 C water bath under a stream of nitrogen.
16. Add 0.5 ml of boron trifluoride-methanol and cap.
17. Place in a boiling water bath for 15 min.
18. Remove and cool.
19. Add 4.5 ml of deionized water.
20. Clean up the extracts with a Baker 10 Extraction System® using a 3-ml C18 cartridge as follows:
  - a. Draw 1 column length of methanol through the cartridge.
  - b. Draw 2 column lengths of deionized water through the cartridge.
  - c. Draw the 5 ml of sample from step 19 through the cartridge.
  - d. Draw 1 ml of deionized water through the cartridge.
  - e. Draw air through the cartridge for approximately 1 min to dry it.
  - f. Draw 1.5 ml of toluene through the cartridge-collect.



- g. Transfer the toluene to a 5-ml volumetric flask.
- h. Rinse the collection tubes two times with toluene and transfer the rinse to the 5-ml volumetric flask.
- i. Make the volume up to 5 ml with toluene.
- j. Place an aliquot in a GC vial.

Gas chromatograph conditions for analysis of 2,4-D from urine.

<sup>63</sup>Ni electron capture detector

183 cm x 2mm id 1.5% SP-2250/1.95% SP-2401 on 100/120 Supelcoport column

Temperature

Detector - 350 C

Injector - 250 C

Oven - 165 C

95/5 Argon/methane at 40 ml/min

Confirmation of 40 2,4-D samples was done using a 183 cm x 2mm id 3% OV-225 column.

Gas chromatograph conditions for analysis of picloram from urine.

<sup>63</sup>Ni electron capture detector

366 cm x 2mm id 1.5% SP-2250/1.95% SP-2401 on 100/120 Supelcoport column.

Temperature

Detector - 350 C

Injector - 250 C

Oven - 215 C

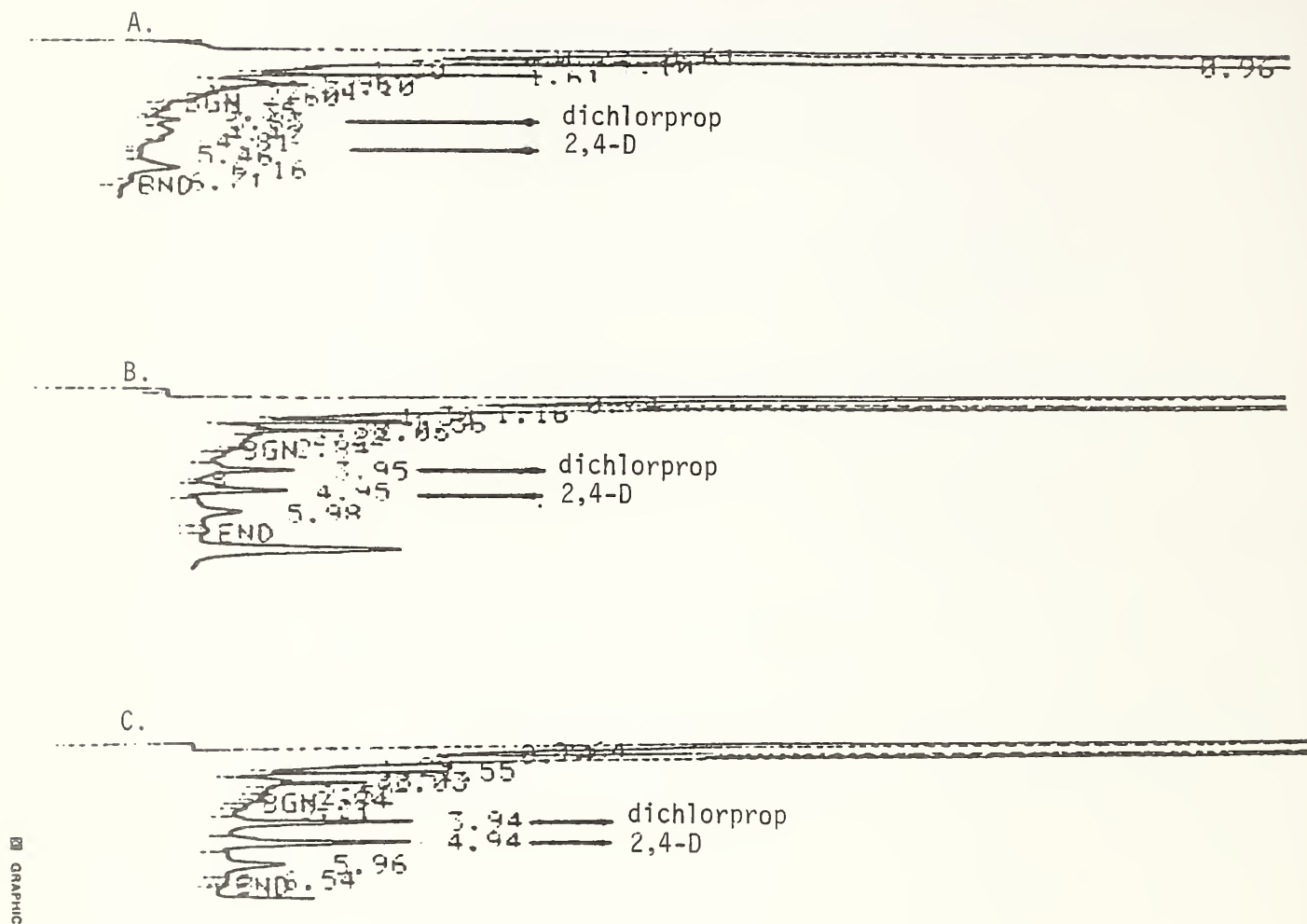
95/5 Argon/methane at 50 ml/min

Confirmation of picloram samples was done using a 366 cm x 2 mm id



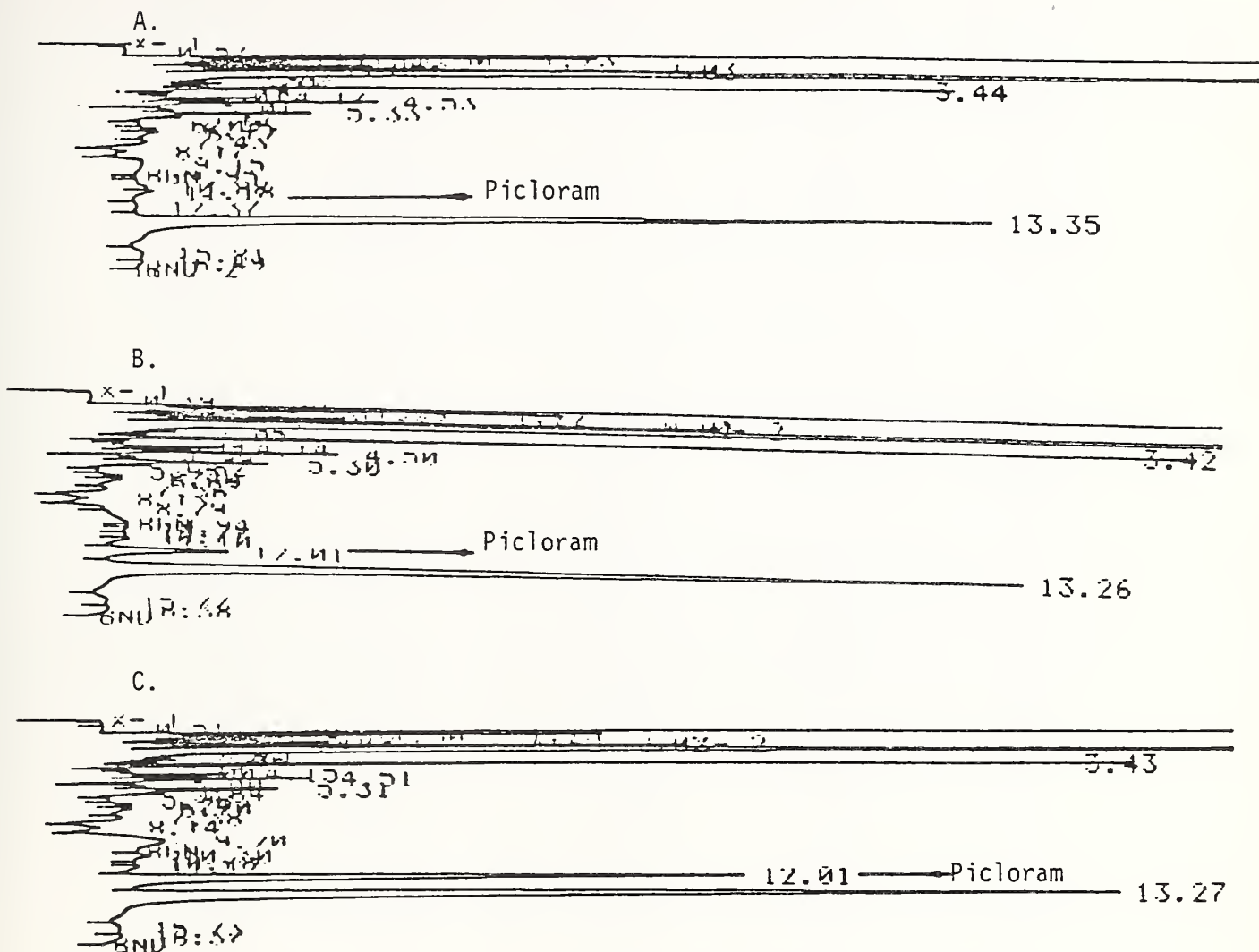
3% OV-225 column. Copies of chromatograms are given in Figure 8 for 2,4-D and dichlorprop and Figure 9 for picloram.

Figure 8 Chromatograms of urine samples for 2,4-D and dichlorprop.



A. Urine blank B. Urine containing 0.05 ppm 2,4-D and dichlorprop C. Urine containing 0.10 ppm 2,4-D and dichlorprop.

Figure 9. Chromatograms of urine samples for picloram.



A. Urine blank B. Urine containing 0.02 ppm picloram C. Urine containing 0.10 ppm picloram

The procedures used in preparation of the lab fortified and field fortified samples follows.

Field Fortified Samples: A 24-hour urine sample collected the day prior to spraying from one of the workers was selected. The sample was weighed, and an aliquot was taken for analysis. From the remaining urine, aliquots were taken, each aliquot being approximately 50 ml. The weight of each aliquot was recorded. An Oxford pipettor was set at 5 ml, and the setting verified by weighing 5 ml of water. To each aliquot was added 5 ml of either 1 ppm or 5 ppm of the herbicide in water. For each fortified sample the following information was recorded: sample number for the batch of urine being fortified, weight of urine fortified, volume of herbicide solution added (5 ml), and concentration of herbicide solution added. These samples were interspersed, stored, and shipped to the Altheimer Laboratory with the unknown samples. No field fortified samples were prepared for picloram or dichlorprop.

However, lab-fortified samples were prepared and interspersed among the field samples soon after arrival in the laboratory. The recovery data for the field fortified samples are given in Table 11.

Lab Fortified Samples: The samples were prepared in a manner analogous to the field fortified samples; however, the urine used was from laboratory personnel. These samples were interspersed with samples from the field as they came in. They were not subject to field storage conditions or shipping conditions. For the picloram samples 5 ml of 4 ppm picloram was used. The recovery data for the lab fortified samples are in Tables 12 (2,4-D), Table 13

Table 11. Recovery Data for Urine Samples Field Fortified with 2,4-D.

| Lab Number | Code Number | 2,4-D<br>Fortification<br>(ppm) | 2,4-D<br>Found<br>(ppm) | % Recovery |
|------------|-------------|---------------------------------|-------------------------|------------|
| 1849       | A31-16      | 0.499                           | 0.535                   | 107        |
| 1874       | A31-28      | 0.581                           | 0.588                   | 101        |
| 1895       | A31-13      | 0.089                           | 0.083                   | 93         |
| 1914       | A31-29      | 0.461                           | 0.478                   | 104        |
| 1915       | A31-3       | 0.487                           | 0.486                   | 100        |
| 1916       | A31-14      | 0.084                           | 0.078                   | 93         |
| 1917       | A31-15      | 0.094                           | 0.089                   | 95         |
| 1935       | A31-4       | 0.097                           | 0.082                   | 85         |
| 2176       | A31-7       | 0.091                           | 0.085                   | 93         |
| 2200       | A31-22      | 0.463                           | 0.510                   | 110        |
| 2225       | A31-23      | 0.493                           | 0.397                   | 81         |
| 2232       | A31-8       | 0.088                           | 0.076                   | 86         |
| 2274       | A31-11      | 0.085                           | 0.128                   | 150        |
| 2275       | A31-12      | 0.096                           | 0.129                   | 134        |
| 2276       | A31-26      | 0.446                           | 0.473                   | 106        |
| 2277       | A31-27      | 0.482                           | 0.471                   | 98         |
| 2278       | A31-25      | 0.494                           | 0.579                   | 117        |
| 2055       | B31-13      | 0.096                           | 0.077                   | 80         |
| 2060       | B31-28      | 0.487                           | 0.352                   | 72         |
| 2064       | B31-15      | 0.091                           | 0.073                   | 80         |
| 2065       | B31-14      | 0.092                           | 0.075                   | 82         |
| 2066       | B31-29      | 0.412                           | 0.281                   | 68         |
| 2067       | B31-30      | 0.382                           | 0.284                   | 74         |
| 2076       | B31-1       | 0.097                           | 0.095                   | 98         |
| 2098       | B31-16      | 0.456                           | 0.497                   | 109        |
| 2104       | B31-2       | 0.087                           | 0.098                   | 113        |
| 2105       | B31-3       | 0.099                           | 0.125                   | 126        |
| 2106       | B31-17      | 0.432                           | 0.516                   | 119        |
| 2107       | B31-18      | 0.464                           | 0.547                   | 121        |
| 2311       | B32-8       | 0.084                           | 0.079                   | 94         |
| 2340       | B32-16      | 0.445                           | 0.347                   | 78         |
| 2356       | B32-10      | 0.087                           | 0.066                   | 76         |
| 2357       | B32-9       | 0.086                           | 0.069                   | 80         |
| 2358       | B32-17      | 0.419                           | 0.347                   | 83         |
| 2359       | B32-18      | 0.422                           | 0.324                   | 77         |
| 2495       | B32-25      | 0.430                           | 0.358                   | 83         |
| 2496       | B32-26      | 0.422                           | 0.385                   | 91         |
| 2498       | B32-3       | 0.082                           | 0.093                   | 113        |
| 2499       | B32-27      | 0.424                           | 0.403                   | 95         |
| 2500       | B32-4       | 0.082                           | 0.055                   | 67         |
| 2501       | B32-5       | 0.088                           | 0.057                   | 65         |
| 2507       | B32-20      | 0.444                           | 0.350                   | 79         |
| 2514       | B32-6       | 0.083                           | 0.088                   | 106        |
| 2524       | B32-11      | 0.088                           | 0.099                   | 112        |
| 2540       | B32-15      | 0.078                           | 0.098                   | 126        |
| 2549       | B32-21      | 0.444                           | 0.451                   | 102        |
| 2566       | B32-19      | 0.451                           | 0.420                   | 93         |
| 2581       | B32-23      | 0.453                           | 0.493                   | 109        |

Table 11 (cont.)

| Lab Number | Code Number | 2,4-D<br>Fortification<br>(ppm) | 2,4-D<br>Found<br>(ppm) | % Recovery |
|------------|-------------|---------------------------------|-------------------------|------------|
| 2585       | B32-24      | 0.448                           | 0.325                   | 73         |
| 2592       | B32-13      | 0.088                           | 0.085                   | 97         |
| 2593       | B32-12      | 0.088                           | 0.087                   | 99         |
| 2595       | B32-22      | 0.450                           | 0.354                   | 79         |
| 2602       | B32-14      | 0.084                           | 0.080                   | 95         |
| 2610       | B32-30      | 0.442                           | 0.364                   | 82         |
| 2611       | B32-2       | 0.085                           | 0.087                   | 102        |
| 2616       | B32-29      | 0.421                           | 0.352                   | 84         |
| 2622       | B32-28      | 0.438                           | 0.377                   | 86         |
| 2364       | C32-18      | 0.454                           | 0.420                   | 93         |
| 2381       | C32-1       | 0.089                           | 0.066                   | 74         |
| 2402       | C32-3       | 0.091                           | 0.127                   | 140        |
| 2405       | C32-16      | 0.450                           | 0.430                   | 96         |
| 2412       | C32-2       | 0.090                           | 0.098                   | 109        |
| 2422       | C32-17      | 0.451                           | 0.476                   | 106        |
| 2680       | C31-1       | 0.085                           | 0.271                   | 84*        |
| 2682       | C31-16      | 0.520                           | 0.622                   | 81*        |
| 2685       | C31-18      | 0.471                           | 0.551                   | 75*        |
| 2686       | C31-3       | 0.115                           | 0.278                   | 68*        |
| 2687       | C31-17      | 0.676                           | 0.744                   | 80*        |
| 2688       | C31-2       | 0.099                           | 0.272                   | 72*        |
| 2725       | C31-6       | 0.103                           | 0.211                   | 11*        |
| 2739       | C31-19      | 0.478                           | 0.581                   | 80*        |
| 2751       | C31-21      | 0.477                           | 0.583                   | 80*        |
| 2762       | C31-4       | 0.113                           | 0.284                   | 74*        |
| 2768       | C31-5       | 0.089                           | 0.260                   | 103*       |
| 2775       | C32-15      | 0.088                           | 0.076                   | 86         |
| 2782       | C32-28      | 0.449                           | 0.406                   | 90         |
| 2788       | C32-14      | 0.088                           | 0.083                   | 94         |
| 2794       | C32-29      | 0.454                           | 0.380                   | 84         |
| 2801       | C32-30      | 0.442                           | 0.415                   | 94         |
| 2803       | C32-13      | 0.090                           | 0.085                   | 94         |
| 2804       | C32-26      | 0.442                           | 0.413                   | 93         |
| 2805       | C32-25      | 0.445                           | 0.437                   | 98         |
| 2806       | C32-12      | 0.090                           | 0.093                   | 103        |
| 2811       | C32-10      | 0.088                           | 0.134                   | 152        |
| 2814       | C32-11      | 0.090                           | 0.132                   | 147        |
| 2815       | C32-27      | 0.441                           | 0.490                   | 111        |
| 2824       | C32-6       | 0.091                           | 0.080                   | 88         |
| 2825       | C32-5       | 0.090                           | 0.074                   | 82         |
| 2826       | C32-21      | 0.438                           | 0.332                   | 76         |
| 2827       | C32-4       | 0.088                           | 0.081                   | 92         |
| 2830       | C32-19      | 0.425                           | 0.353                   | 83         |
| 2831       | C32-20      | 0.452                           | 0.384                   | 85         |
| 2833       | C32-24      | 0.453                           | 0.377                   | 83         |
| 2834       | C32-22      | 0.451                           | 0.391                   | 87         |
| 2837       | C32-9       | 0.091                           | 0.077                   | 85         |
| 2838       | C32-7       | 0.088                           | 0.074                   | 84         |
| 2841       | C32-8       | 0.089                           | 0.080                   | 90         |



Table 11 (cont.)

| Lab Number | Code Number | 2,4-D<br>Fortification<br>(ppm) | 2,4-D<br>Found<br>(ppm) | % Recovery |
|------------|-------------|---------------------------------|-------------------------|------------|
| 2869       | C31-30      | 0.429                           | 0.554                   | 83*        |
| 2872       | C31-14      | 0.089                           | 0.243                   | 48*        |
| 2875       | C31-29      | 0.562                           | 0.699                   | 89*        |
| 2879       | C31-23      | 0.474                           | 0.602                   | 85*        |
| 2884       | C31-27      | 0.445                           | 0.585                   | 87*        |
| 2890       | C31-15      | 0.111                           | 0.276                   | 68*        |
| 2895       | C31-22      | 0.501                           | 0.585                   | 77*        |
| 2900       | C31-10      | 0.113                           | 0.326                   | 112*       |
| 2903       | C31-13      | 0.098                           | 0.288                   | 90*        |
| 2908       | C31-26      | 0.552                           | 0.650                   | 82*        |
| 2909       | C31-7       | 0.096                           | 0.218                   | 19*        |
| 2910       | C31-11      | 0.096                           | 0.221                   | 22*        |
| 2912       | C31-8       | 0.107                           | 0.325                   | 117*       |
| 2913       | C31-28      | 0.548                           | 0.735                   | 98*        |
| 2916       | C31-9       | 0.095                           | 0.285                   | 89*        |
| 2919       | C31-24      | 0.474                           | 0.659                   | 97         |
| 3037       | D31-3       | 0.090                           | 0.069                   | 77         |
| 3065       | D31-7       | 0.480                           | 0.364                   | 76         |
| 3093       | D31-2       | 0.091                           | 0.077                   | 85         |
| 3100       | D31-8       | 0.518                           | 0.377                   | 73         |
| 3110       | D31-1       | 0.099                           | 0.085                   | 86         |
| 3124       | D31-9       | 0.500                           | 0.359                   | 72         |
| 3141       | D31-12      | 0.395                           | 0.293                   | 74         |
| 3146       | D31-10      | 0.505                           | 0.380                   | 75         |
| 3153       | D31-5       | 0.099                           | 0.098                   | 99         |
| 3163       | D31-6       | 0.106                           | 0.088                   | 83         |
| 3187       | D31-4       | 0.109                           | 0.022                   | 20         |
| 3238       | D31-11      | 0.567                           | 0.505                   | 89         |
| 3391       | D33-2       | 0.125                           | 0.089                   | 71         |
| 3417       | D33-18      | 0.641                           | 0.622                   | 97         |
| 3453       | D33-17      | 0.661                           | 0.475                   | 72         |
| 3456       | D33-16      | 0.679                           | 0.496                   | 73         |
| 3462       | D33-1       | 0.122                           | 0.094                   | 77         |
| 3463       | D33-12      | 0.132                           | 0.100                   | 76         |
| 3469       | D33-6       | 0.143                           | 0.091                   | 64         |
| 3475       | D33-27      | 0.658                           | 0.442                   | 67         |
| 3479       | D33-26      | 0.782                           | 0.560                   | 72         |
| 3483       | D33-11      | 0.133                           | 0.107                   | 80         |
| 3488       | D33-7       | 0.135                           | 0.105                   | 77         |
| 3508       | D33-8       | 0.128                           | 0.100                   | 78         |
| 3513       | D33-24      | 0.683                           | 0.484                   | 71         |
| 3516       | D33-22      | 0.741                           | 0.531                   | 72         |
| 3520       | D33-25      | 0.595                           | 0.376                   | 63         |
| 3523       | D33-21      | 0.747                           | 0.487                   | 65         |
| 3528       | D33-19      | 0.749                           | 0.518                   | 69         |
| 3529       | D33-5       | 0.152                           | 0.125                   | 82         |
| 3533       | D33-4       | 0.155                           | 0.130                   | 84         |
| 3536       | D33-10      | 0.138                           | 0.123                   | 89         |
| 3537       | D33-20      | 0.758                           | 0.643                   | 85         |

Table 11 (cont.)

| Lab Number | Code Number | 2,4-D                  | 2,4-D          | % Recovery |
|------------|-------------|------------------------|----------------|------------|
|            |             | Fortification<br>(ppm) | Found<br>(ppm) |            |
| 3562       | D33-28      | 0.683                  | 0.560          | 82         |
| 3563       | D33-15      | 0.125                  | 0.147          | 118        |
| 3564       | D33-29      | 0.729                  | 0.559          | 77         |
| 3565       | D33-13      | 0.143                  | 0.134          | 94         |
| 3566       | D33-14      | 0.133                  | 0.165          | 124        |
| 3567       | D33-30      | 0.861                  | 0.791          | 92         |

\*Sample number C2-1 was used to prepare all these field fortified samples. When analyzed C2-1 was found to contain 0.200 ppm 2,4-D. To determine the 2,4-D found in the samples 0.200 ppm was subtracted from the value as determined by GC. This net value was used to determine the % recovery.

Percent recovery with a 95% confidence interval for low level fortified samples is  $90 \pm 6\%$ ,  $n = 74$  samples analyzed.

Percent recovery with a 95% confidence interval for high level fortified samples is  $87 \pm 3\%$ ,  $n = 77$  samples analyzed.

Table 12. Recovery Data for Urine Samples Lab Fortified with 2,4-D.

| Lab Number | 2,4-D<br>Fortification<br>(ppm) | 2,4-D<br>Found<br>(ppm) | % Recovery |
|------------|---------------------------------|-------------------------|------------|
| 1863       | 0.084                           | 0.092                   | 109        |
| 1872       | 0.087                           | 0.092                   | 106        |
| 1922       | 0.092                           | 0.095                   | 103        |
| 1933       | 0.091                           | 0.098                   | 108        |
| 1956       | 0.091                           | 0.092                   | 101        |
| 1972       | 0.092                           | 0.095                   | 103        |
| 1979       | 0.096                           | 0.098                   | 102        |
| 1993       | 0.097                           | 0.107                   | 110        |
| 2057       | 0.096                           | 0.075                   | 78         |
| 2072       | 0.092                           | 0.108                   | 117        |
| 2081       | 0.093                           | 0.108                   | 116        |
| 2376       | 0.090                           | 0.082                   | 91         |
| 2366       | 0.103                           | 0.065                   | 63         |
| 2285       | 0.084                           | 0.095                   | 113        |
| 2301       | 0.083                           | 0.083                   | 100        |
| 2307       | 0.086                           | 0.096                   | 112        |
| 2161       | 0.086                           | 0.071                   | 83         |
| 2386       | 0.082                           | 0.104                   | 127        |
| 2553       | 0.083                           | 0.116                   | 140        |
| 2568       | 0.092                           | 0.108                   | 117        |
| 2572       | 0.090                           | 0.101                   | 112        |
| 2502       | 0.089                           | 0.070                   | 79         |
| 2497       | 0.089                           | 0.093                   | 104        |
| 2426       | 0.104                           | 0.071                   | 68         |
| 2399       | 0.096                           | 0.130                   | 135        |
| 2627       | 0.093                           | 0.087                   | 94         |
| 2656       | 0.091                           | 0.092                   | 101        |
| 2671       | 0.092                           | 0.118                   | 128        |
| 2723       | 0.090                           | 0.084                   | 93         |
| 2783       | 0.093                           | 0.103                   | 111        |
| 2823       | 0.096                           | 0.093                   | 97         |
| 2870       | 0.097                           | 0.083                   | 86         |
| 3220       | 0.093                           | 0.089                   | 96         |
| 3247       | 0.092                           | 0.081                   | 88         |
| 2921       | 0.450                           | 0.400                   | 89         |
| 3053       | 0.449                           | 0.427                   | 95         |
| 1940       | 0.503                           | 0.504                   | 100        |
| 1964       | 0.487                           | 0.508                   | 104        |
| 2001       | 0.427                           | 0.455                   | 106        |
| 2061       | 0.498                           | 0.349                   | 70         |
| 2186       | 0.499                           | 0.359                   | 72         |
| 2664       | 0.456                           | 0.420                   | 92         |
| 2294       | 0.454                           | 0.430                   | 95         |
| 2343       | 0.457                           | 0.493                   | 108        |
| 2328       | 0.446                           | 0.475                   | 106        |
| 2313       | 0.436                           | 0.444                   | 102        |
| 2251       | 0.465                           | 0.297                   | 64         |
| 2632       | 0.449                           | 0.345                   | 77         |
| 2647       | 0.455                           | 0.424                   | 93         |

Table 12 (cont.)

| Lab Number | 2,4-D<br>Fortification<br>(ppm) | 2,4-D<br>Found<br>(ppm) | % Recovery |
|------------|---------------------------------|-------------------------|------------|
| 2531       | 0.454                           | 0.432                   | 95         |
| 2519       | 0.442                           | 0.388                   | 88         |
| 2557       | 0.483                           | 0.357                   | 97         |
| 2605       | 0.475                           | 0.462                   | 74         |
| 3172       | 0.444                           | 0.302                   | 68         |
| 3058       | 0.456                           | 0.360                   | 79         |
| 2746       | 0.447                           | 0.392                   | 88         |
| 2756       | 0.473                           | 0.455                   | 96         |
| 3241       | 0.452                           | 0.368                   | 81         |
| 2816       | 0.524                           | 0.463                   | 88         |
| 3075       | 0.505                           | 0.372                   | 74         |
| 3089       | 0.515                           | 0.419                   | 81         |
| 2413       | 0.495                           | 0.502                   | 101        |
| 2808       | 0.438                           | 0.404                   | 92         |
| 3137       | 0.463                           | 0.342                   | 74         |
| 3103       | 0.500                           | 0.369                   | 74         |
| 3128       | 0.519                           | 0.370                   | 71         |
| 2893       | 0.494                           | 0.270                   | 55         |
| 2096       | 0.463                           | 0.399                   | 86         |
| 2103       | 0.534                           | 0.559                   | 105        |
| 1881       | 0.489                           | 0.468                   | 96         |
| 1887       | 0.444                           | 0.408                   | 92         |
| 1907       | 0.449                           | 0.413                   | 92         |

Percent recovery with a 95% confidence interval for the low level fortified samples is  $103 \pm 6\%$ , (34 samples analyzed).

Percent recovery with a 95% confidence interval for the high level fortified samples is  $87 \pm 4\%$ , (38 samples analyzed).

Table 13. Recovery Data for Urine Samples Fortified with Dichlorprop (Lab Spikes).

| Lab Number | Dichlorprop<br>Fortification<br>(ppm) | Dichlorprop<br>Found<br>(ppm) | % Recovery |
|------------|---------------------------------------|-------------------------------|------------|
| 1869       | 0.092                                 | 0.126                         | 137        |
| 1876       | 0.097                                 | 0.120                         | 124        |
| 1929       | 0.094                                 | 0.100                         | 106        |
| 1948       | 0.091                                 | 0.145                         | 159        |
| 2166       | 0.102                                 | 0.089                         | 87         |
| 2174       | 0.109                                 | 0.094                         | 86         |
| 1839       | 0.762                                 | 0.822                         | 108        |
| 1885       | 0.500                                 | 0.479                         | 96         |
| 1900       | 0.436                                 | 0.558                         | 128        |
| 2020       | 0.448                                 | 0.547                         | 122        |
| 2024       | 0.447                                 | 0.435                         | 97         |
| 2036       | 0.530                                 | 0.520                         | 98         |

Percent recovery with a 95% confidence interval for the low level fortified samples is  $117 \pm 30$  (6 samples analyzed).  
Percent recovery with a 95% confidence interval for the high level fortified samples is  $108 \pm 15$  (6 samples analyzed).

Table 14. Recovery Data for Urine Samples Lab Fortified with Picloram.

| Lab number | Picloram<br>fortification (ppm) | Picloram<br>found (ppm) | %<br>Recovery |
|------------|---------------------------------|-------------------------|---------------|
| 2723A      | 0.076                           | 0.062                   | 82            |
| 2738A      | 0.377                           | 0.457                   | 121           |
| 2760A      | 0.079                           | 0.065                   | 82            |
| 2769A      | 0.099                           | 0.082                   | 83            |
| 2789A      | 0.374                           | 0.303                   | 81            |
| 2810A      | 0.086                           | 0.068                   | 79            |
| 2827A      | 0.413                           | 0.309                   | 75            |
| 2840A      | 0.090                           | 0.113                   | 126           |
| 2882A      | 0.380                           | 0.351                   | 92            |
| 2899A      | 0.478                           | 0.468                   | 98            |
| 2918A      | 0.085                           | 0.062                   | 73            |
| 3041       | 0.318                           | 0.265                   | 83            |
| 3048       | 0.355                           | 0.304                   | 86            |
| 3069       | 0.096                           | 0.082                   | 85            |
| 3086       | 0.386                           | 0.303                   | 78            |
| 3114       | 0.091                           | 0.068                   | 75            |
| 3204       | 0.097                           | 0.052                   | 54            |
| 3224       | 0.332                           | 0.252                   | 76            |
| 3234       | 0.348                           | 0.236                   | 68            |

Percent recovery with a 95% confidence interval for low level fortified samples is  $82 \pm 15\%$ , (9 samples analyzed).  
Percent recovery with a 95% confidence interval for high level fortified samples is  $86 \pm 11\%$ , (10 samples analyzed).

(dichlorprop), and Table 14 (picloram).

The value of having two types of fortified samples plus routine injection of a standard is illustrated by the following.

For one group of people, C1-C7, the urine collected 24 h prior to spraying contained measurable levels of 2,4-D and dichlorprop. Normally such samples should not contain detectable levels. The analytical standard that was injected after every fifth sample indicated that the instruments were working properly. The two lab fortified samples gave values within the expected range for those samples indicating that the sample preparation process was correct. All 6 field fortified samples (3 low level and 3 high level), however, gave values higher than expected. The batch of urine that had been used to prepare the field fortified samples showed a level of 0.200 ppm 2,4-D. When this value was subtracted from the observed 2,4-D levels for the field fortified samples, the value obtained was consistent with previously analyzed field fortified samples. Contrary to instructions which had been issued, lack of communications allowed this group of applicators to be exposed to Tordon 101-R® prior to the study. The data were corrected for this pre-exposure before statistical analysis.

The amount of urine excreted in a 24-h period can vary considerably between people on any given day and among days for any one person. For example, one day a person excreted 6300 ml of urine while a colleague doing similar work excreted only 606 ml. In order to determine the amount of herbicide excreted it is necessary to know both the concentration of the compound in the urine and the volume of urine. To help verify that all the urine had been collected, total



creatinine excreted in each sample was measured. The mg of creatinine excreted per person per day is given in Table 33.

## RESULTS AND DISCUSSION

### Urinary Excretion:

Information presented in Tables 15-22 lists worker number, volume urine excreted in 24 h, herbicide concentration in urine, and milligrams of herbicide excreted each 24 h beginning one day before application and continuing for 4 days after application for both the T<sub>1</sub> and T<sub>2</sub> portions of the study. All values for amounts of herbicides excreted in urine have been corrected for percentage recovery. Specific urine excretion data on the dichlorprop backpack crew are given in Table 15; 2,4-D backpack crew Table 16; 2,4-D injection bar crew Table 17; 2,4-D hypohatchet crew Table 18; 2,4-D hack and squirt crew Table 19; picloram injection bar crew Table 20; picloram hypohatchet crew Table 21; and picloram hack and squirt crew Table 22. During discussion of these data the terms "absorbed dose" and "amount of herbicide excreted in urine" are used interchangeably as estimates of exposure since the total urine excreted was collected and evaluated. Sauerhoff et al. (1977) have shown that over 95% of an absorbed dose of 2,4-D is excreted within 5 days.

### Extent of Worker Exposure to Herbicides:

Most applicators received some exposure to the herbicides they were applying. Analysis of samples from urine collected on the application day and the next 4 days revealed that 194 of 199 dichlorprop samples from backpack sprayers (Table 15) contained detectable levels, and in the same samples 2,4-D was found in 195 of the 199 samples (Table 16). Of the 200 urine samples from the injection bar crew 149 contained detectable 2,4-D levels (Table 17). In the hypohatchet crew

Table 15. Urine Data for Backpack Crew Applying Dichlorprop

T-1

T-2

| Day               | 1               | 2*    | 3     | 4    | 5    | 6    | 7    | 8*    | 9     | 10    | 11   | 12    |
|-------------------|-----------------|-------|-------|------|------|------|------|-------|-------|-------|------|-------|
| A-1               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1190            | 1151  | 1442  | 1517 | 3502 | 993  | 1285 | 981   | 3004  | 867   | 2542 | 1425  |
| Urine Conc.(mg/L) | nd <sup>a</sup> | 6.06  | 2.002 | .524 | .111 | .247 | .178 | 1.692 | 1.319 | .255  | .268 | .484  |
| Amt. in Urine(mg) | nd              | 6.97  | 2.89  | 0.79 | 0.39 | 0.25 | 0.23 | 1.66  | 3.96  | 0.22  | 0.68 | 0.69  |
| A-2               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1178            | 2014  | 2270  | 1514 | 1993 | 1675 | 880  | 1547  | 1427  | 2113  | 2396 | 1491  |
| Urine Conc.(mg/L) | nd              | 1.450 | .767  | .237 | .264 | .057 | .068 | .395  | .678  | .166  | .309 | .381  |
| Amt. in Urine(mg) | nd              | 2.92  | 1.74  | 0.36 | 0.53 | 0.10 | 0.06 | 0.61  | 0.97  | 0.35  | 0.74 | 0.57  |
| A-3               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 479             | 977   | 1406  | 2342 | 1852 | 604  | 1306 | b     | 677   | 1089  | 1051 | 935   |
| Urine Conc.(mg/L) | nd              | 2.068 | .860  | .388 | .385 | .488 | .628 |       | .813  | .466  | .251 | .145  |
| Amt. in Urine(mg) | nd              | 2.02  | 1.21  | 0.91 | 0.71 | 0.29 | 0.82 |       | 0.55  | 0.51  | 0.26 | 0.14  |
| A-4               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1048            | 801   | 2141  | 1897 | 1705 | 808  | 1952 | 1664  | 1360  | 2613  | 1909 | 1199  |
| Urine Conc.(mg/L) | nd              | 2.609 | 2.646 | .738 | .586 | .747 | .242 | 2.992 | .472  | .211  | .318 | 1.482 |
| Amt. in Urine(mg) | nd              | 2.09  | 5.66  | 1.40 | 1.00 | 0.60 | 0.47 | 4.98  | 0.64  | 0.55  | 0.61 | 1.78  |
| A-5               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 804             | 846   | 1604  | 1760 | 1341 | 1253 | 691  | 538   | 705   | 1166  | 2376 | 1281  |
| Urine Conc.(mg/L) | nd              | 2.172 | .769  | .174 | .071 | nd   | .382 | 4.505 | 2.161 | .339  | .122 | .127  |
| Amt. in Urine(mg) | nd              | 1.84  | 1.23  | 0.31 | 0.10 | nd   | 0.26 | 2.39  | 1.52  | 0.40  | 0.29 | 0.16  |
| A-6               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 719             | 855   | 2017  | 1190 | 1396 | 797  | 1237 | 1467  | 1375  | 3735  | 2024 | 1319  |
| Urine Conc.(mg/L) | 1.676           | 2.211 | .853  | .548 | .215 | .468 | .245 | 1.568 | 1.874 | .240  | .351 | .230  |
| Amt. in Urine(mg) | 1.21            | 1.89  | 1.72  | 0.65 | 0.30 | 0.37 | 0.30 | 2.30  | 2.58  | 0.90  | 0.74 | 0.30  |
| A-7               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 2401            | 2029  | 1469  | 2485 | 2132 | 1090 | 1935 | 3041  | 2380  | 1576  | 2263 | 1452  |
| Urine Conc.(mg/L) | .130            | 2.258 | 1.498 | .664 | .292 | .247 | .392 | .346  | .348  | .616  | .083 | .288  |
| Amt. in Urine(mg) | 0.31            | 4.58  | 2.20  | 1.65 | 0.62 | 0.27 | 0.76 | 1.05  | 0.83  | 0.97  | 0.19 | 0.42  |
| A-8               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 936             | 1203  | 977   | 920  | 1136 | 1033 | 1183 | 686   | 1195  | 1076  | 1257 | 1189  |
| Urine Conc.(mg/L) | nd              | 2.205 | 1.199 | .433 | .222 | .267 | .298 | 3.563 | .723  | .251  | .177 | .459  |
| Amt. in Urine(mg) | nd              | 2.65  | 1.17  | 0.40 | 0.25 | 0.28 | 0.35 | 2.44  | 0.86  | 0.27  | 0.22 | 0.55  |
| A-9               |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1210            | 2448  | 889   | 1749 | 1126 | 487  | 796  | 615   | 805   | 1254  | 473  | 494   |
| Urine Conc.(mg/L) | nd              | .958  | 1.826 | .469 | .443 | .456 | .275 | .786  | .327  | .619  | .504 | .436  |
| Amt. in Urine(mg) | nd              | 2.34  | 1.62  | 0.82 | 0.50 | 0.22 | 0.22 | 0.48  | 0.26  | 0.78  | 0.24 | 0.22  |
| A-10              |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1450            | 1574  | 1849  | 1696 | 1004 | 1286 | 1014 | 633   | 1157  | 1090  | 1855 | 1575  |
| Urine Conc.(mg/L) | nd              | 1.557 | .868  | .368 | .260 | .264 | .294 | 2.982 | .710  | 1.031 | .295 | .263  |
| Amt. in Urine(mg) | nd              | 2.45  | 1.61  | 0.62 | 0.26 | 0.34 | 0.30 | 1.89  | 0.82  | 1.12  | 0.55 | 0.41  |
| A-11              |                 |       |       |      |      |      |      |       |       |       |      |       |
| Urine Vol.(ml)    | 1215            | 1500  | 1511  | 2044 | 1590 | 1285 | 1226 | 1038  | 1589  | 2113  | 102  | 1436  |
| Urine Conc.(mg/L) | .078            | 1.284 | .820  | .196 | .124 | nd   | .267 | .876  | 1.428 | .385  | .503 | .126  |
| Amt. in Urine(mg) | 0.09            | 1.93  | 1.24  | 0.40 | 0.20 | nd   | 0.33 | 0.91  | 2.27  | 0.81  | 0.05 | 0.18  |

Table 15. (Cont.)

T-1

T-2

| Day                | 1     | 2*    | 3     | 4     | 5     | 6    | 7     | 8*    | 9     | 10    | 11    | 12    |
|--------------------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| A-12               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 914   | 940   | 1589  | 1397  | 1720  | 1875 | 1209  | 1430  | 1204  | 1408  | 1341  | 1354  |
| Urine Conc. (mg/L) | nd    | 3.273 | 2.482 | .692  | .314  | .092 | 1.206 | 2.294 | .656  | .837  | .149  | .330  |
| Amt. in Urine(mg)  | nd    | 3.08  | 3.94  | 0.97  | 0.54  | 0.17 | 1.46  | 3.28  | 0.79  | 1.23  | 0.20  | 0.45  |
| A-13               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1393  | 909   | 1776  | 2098  | 1614  | 774  | 1307  | 1269  | 2244  | 1443  | 1167  | 804   |
| Urine Conc. (mg/L) | nd    | 2.635 | 1.228 | .338  | .067  | .234 | .299  | 2.294 | 1.265 | .126  | .224  | .217  |
| Amt. in Urine(mg)  | nd    | 2.40  | 2.18  | 0.71  | 0.11  | 0.18 | 0.39  | 2.91  | 2.84  | 0.18  | 0.26  | 0.17  |
| A-14               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1235  | 969   | 1169  | 1680  | 1509  | 2318 | 1322  | 1149  | 1419  | 1642  | 1250  | 1989  |
| Urine Conc. (mg/L) | .069  | 5.672 | 1.480 | .802  | .363  | .631 | 1.415 | 2.953 | 1.280 | .232  | 1.968 | 1.628 |
| Amt. in Urine(mg)  | 0.08  | 5.50  | 1.73  | 1.35  | 0.55  | 1.46 | 1.94  | 3.39  | 1.82  | 0.38  | 2.46  | 2.93  |
| A-15               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1227  | 1646  | 2585  | 2044  | 3031  | 955  | 1260  | 1473  | 1234  | 2220  | 2658  | 1418  |
| Urine Conc. (mg/L) | .185  | 1.591 | 1.238 | .664  | .116  | nd   | 1.302 | 4.372 | .628  | .165  | .283  | .294  |
| Amt. in Urine(mg)  | 0.23  | 2.62  | 3.20  | 1.36  | 0.35  | nd   | 1.64  | 6.44  | 0.77  | 0.37  | 0.75  | 0.42  |
| A-16               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 758   | 1131  | 1550  | 2211  | 1226  | 1216 | 1799  | 1269  | 1213  | 2073  | 2284  | 1433  |
| Urine Conc. (mg/L) | 1.048 | 2.626 | 1.584 | .426  | .488  | .167 | .163  | 2.427 | 2.459 | .565  | .376  | .844  |
| Amt. in Urine(mg)  | 0.79  | 2.97  | 2.46  | 0.94  | 0.60  | 0.20 | 0.29  | 3.08  | 2.98  | 1.17  | 0.86  | 1.21  |
| A-17               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 942   | 969   | 1454  | 2267  | 1911  | 1288 | 894   | 3414  | 966   | 1583  | 1143  | 3118  |
| Urine Conc. (mg/L) | nd    | 2.453 | 1.224 | .320  | .390  | .263 | .776  | 1.202 | .604  | .198  | .285  | .276  |
| Amt. in Urine(mg)  | nd    | 2.38  | 1.78  | 0.72  | 0.75  | 0.34 | 0.69  | 4.10  | 0.61  | 0.31  | 0.33  | 0.86  |
| A-18               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1796  | 2174  | 3496  | 2918  | 2615  | 3259 | 1500  | 2162  | 1329  | 2387  | 3677  | 2689  |
| Urine Conc. (mg/L) | nd    | .584  | .242  | .130  | .135  | nd   | .170  | 1.683 | 2.281 | .447  | .100  | .620  |
| Amt. in Urine(mg)  | nd    | 1.27  | 0.84  | 0.38  | 0.35  | nd   | 0.25  | 3.64  | 4.59  | 1.07  | 0.37  | 1.67  |
| A-19               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1045  | 2375  | 3591  | 2913  | 3827  | 1011 | 1359  | 1572  | 1651  | 2131  | 1499  | 2637  |
| Urine Conc. (mg/L) | nd    | .693  | .316  | .076  | .070  | nd   | nd    | 1.610 | .263  | .195  | .067  | 0.18  |
| Amt. in Urine(mg)  | nd    | 1.65  | 1.14  | 0.22  | 0.27  | nd   | nd    | 2.53  | 0.43  | 0.42  | 0.10  | 0.05  |
| A-20               |       |       |       |       |       |      |       |       |       |       |       |       |
| Urine Vol.(ml)     | 1102  | 1044  | 1375  | 1385  | 1585  | 1379 | 1497  | 1585  | 977   | 1294  | 1237  | 1420  |
| Urine Conc. (mg/L) | .615  | 2.420 | 1.613 | 1.774 | 1.798 | .374 | .395  | 1.551 | 2.206 | 1.023 | .409  | 2.406 |
| Amt. in Urine(mg)  | 0.68  | 2.53  | 2.22  | 2.46  | 2.85  | 0.52 | 0.59  | 2.46  | 2.16  | 1.32  | 0.51  | 3.42  |

\*Application day.

<sup>a</sup>Values below the 0.040 mg/L detection limit are listed as nd.<sup>b</sup>Sample lost.



Table 16. Urine Data for Backpack Crew Applying 2,4-D

T-1

T-2

| Day               | 1     | 2*    | 3     | 4    | 5    | 6    | 7     | 8*    | 9     | 10    | 11   | 12    |
|-------------------|-------|-------|-------|------|------|------|-------|-------|-------|-------|------|-------|
| A-1               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1190  | 1151  | 1442  | 1517 | 3502 | 993  | 1285  | 981   | 3004  | 867   | 2542 | 1425  |
| Urine Conc.(mg/L) | nd    | 7.190 | 2.047 | .781 | .157 | .271 | .080  | 3.476 | 1.349 | .155  | .374 | .309  |
| Amt. in Urine(mg) | nd    | 8.28  | 2.95  | 1.18 | 0.55 | 0.27 | 0.10  | 3.41  | 4.05  | 1.38  | 0.95 | 0.44  |
| A-2               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1178  | 2014  | 2270  | 1514 | 1993 | 1675 | 880   | 1547  | 1427  | 2113  | 2396 | 1491  |
| Urine Conc.(mg/L) | nd    | 1.927 | .688  | .282 | 2.71 | .057 | nd    | .679  | .540  | .305  | .175 | .217  |
| Amt. in Urine(mg) | nd    | 3.88  | 1.56  | 0.43 | 0.54 | 0.10 | nd    | 1.05  | 0.78  | 0.64  | 0.42 | 0.32  |
| A-3               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 479   | 977   | 1406  | 2342 | 1852 | 604  | 1307  | b     | 677   | 1089  | 1051 | 935   |
| Urine Conc.(mg/L) | 2.926 | 2.675 | 1.22  | .578 | .395 | .862 | 1.397 |       | 2.286 | .599  | .217 | .171  |
| Amt. in Urine(mg) | 1.40  | 2.61  | 1.76  | 1.35 | 0.73 | 0.52 | 1.82  |       | 1.55  | 0.61  | 0.23 | 0.16  |
| A-4               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1048  | 801   | 2141  | 1897 | 1705 | 808  | 1952  | 1664  | 1360  | 2613  | 1909 | 1199  |
| Urine Conc.(mg/L) | nd    | 2.190 | 1.793 | .568 | .552 | .785 | .303  | 3.279 | 1.298 | 1.57  | .535 | 1.005 |
| Amt. in Urine(mg) | nd    | 1.75  | 3.84  | 1.08 | 0.94 | 0.63 | 0.59  | 5.46  | 1.76  | 0.41  | 1.02 | 1.21  |
| A-5               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 804   | 846   | 1604  | 1760 | 1341 | 1253 | 691   | 531   | 705   | 1166  | 2376 | 1281  |
| Urine Conc.(mg/L) | nd    | 1.318 | 1.224 | .375 | .319 | .150 | .250  | 2.733 | 2.734 | .966  | .105 | .140  |
| Amt. in Urine(mg) | nd    | 1.12  | 1.96  | 0.66 | 0.43 | 0.19 | 0.17  | 1.45  | 1.93  | 1.13  | 0.24 | 0.17  |
| A-6               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 719   | 855   | 2017  | 1190 | 1396 | 797  | 1237  | 1467  | 1375  | 3735  | 2024 | 1319  |
| Urine Conc.(mg/L) | .077  | 1.522 | .575  | .448 | .360 | .260 | .105  | 1.361 | 1.210 | .120  | .183 | .132  |
| Amt. in Urine(mg) | 0.06  | 1.30  | 1.16  | 0.53 | 0.50 | 0.21 | 0.13  | 2.00  | 1.66  | 0.45  | 0.37 | 0.10  |
| A-7               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 2401  | 2029  | 1469  | 2485 | 2132 | 1090 | 1935  | 3041  | 2380  | 1576  | 2263 | 1452  |
| Urine Conc.(mg/L) | nd    | 1.584 | 1.939 | .849 | .310 | .254 | .233  | .448  | .717  | .337  | .167 | .133  |
| Amt. in Urine(mg) | nd    | 3.21  | 2.85  | 2.11 | 0.66 | 0.28 | 0.45  | 1.36  | 1.717 | 0.53  | 0.38 | 0.19  |
| A-8               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 936   | 1203  | 977   | 920  | 1136 | 1033 | 1183  | 686   | 1195  | 1076  | 1257 | 1189  |
| Urine Conc.(mg/L) | nd    | 1.289 | .693  | .375 | .311 | .287 | .199  | 2.563 | .256  | .987  | .438 | .792  |
| Amt. in Urine(mg) | nd    | 1.55  | 0.68  | 0.35 | 0.35 | 0.30 | 0.23  | 1.76  | 3.06  | 1.06  | 0.55 | 0.94  |
| A-9               |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1210  | 2448  | 889   | 1749 | 1126 | 487  | 796   | 615   | 805   | 1254  | 473  | 494   |
| Urine Conc.(mg/L) | .079  | .552  | 1.586 | .469 | .560 | .577 | .374  | 1.275 | .919  | .551  | .301 | .291  |
| Amt. in Urine(mg) | 0.10  | 1.35  | 1.41  | 0.82 | 0.63 | 0.28 | 0.30  | 0.78  | 0.74  | 0.69  | 0.14 | 0.14  |
| A-10              |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1450  | 1574  | 1849  | 1696 | 1004 | 1286 | 1014  | 633   | 1157  | 1090  | 1855 | 1575  |
| Urine Conc.(mg/L) | nd    | 1.591 | .758  | .515 | .396 | .226 | .358  | 1.913 | 2.106 | 2.125 | .412 | .458  |
| Amt. in Urine(mg) | nd    | 1.02  | 1.40  | 0.87 | .040 | 0.29 | 0.36  | 1.21  | 2.44  | 2.32  | 0.76 | 0.72  |
| A-11              |       |       |       |      |      |      |       |       |       |       |      |       |
| Urine Vol.(ml)    | 1215  | 1500  | 1511  | 2044 | 1590 | 1285 | 1226  | 1038  | 1589  | 2113  | 102  | 1436  |
| Urine Conc.(mg/L) | nd    | .755  | .617  | .363 | .198 | nd   | .130  | 1.657 | .891  | .428  | .255 | .160  |
| Amt. in Urine(mg) | nd    | 1.13  | 0.93  | 0.74 | 0.31 | nd   | 0.16  | 1.72  | 1.42  | 0.90  | 0.03 | 0.23  |

Table 16. (Cont.)

T-1

T-2

| Day                | 1    | 2*    | 3     | 4     | 5     | 6    | 7     | 8*    | 9     | 10   | 11    | 12    |
|--------------------|------|-------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|
| A-12               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 914  | 940   | 1589  | 1397  | 1720  | 1875 | 1209  | 1430  | 1204  | 1408 | 1341  | 1354  |
| Urine Conc. (mg/L) | nd   | 1.584 | 1.531 | .905  | .368  | .147 | .998  | 1.795 | 1.262 | .892 | .303  | .416  |
| Amt. in Urine(mg)  | 0.67 | 1.96  | 2.43  | 1.26  | 0.63  | 0.27 | 1.21  | 2.57  | 1.52  | 1.26 | 0.41  | 0.56  |
| A-13               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1393 | 909   | 1776  | 2098  | 1614  | 774  | 1307  | 1269  | 2244  | 1443 | 1167  | 804   |
| Urine Conc. (mg/L) | nd   | 2.103 | 1.595 | .424  | .107  | .225 | .373  | 2.138 | .843  | .363 | .689  | .373  |
| Amt. in Urine(mg)  | nd   | 1.91  | 2.83  | 0.89  | 0.17  | 0.17 | 0.49  | 2.71  | 1.89  | 0.52 | 0.75  | 0.30  |
| A-14               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1235 | 969   | 1169  | 1680  | 1509  | 2318 | 1322  | 1149  | 1419  | 1642 | 1250  | 1989  |
| Urine Conc. (mg/L) | nd   | 4.870 | 6.296 | 1.885 | 1.076 | .856 | 1.230 | 2.171 | 2.593 | 1.23 | 3.960 | 4.037 |
| Amt. in Urine(mg)  | nd   | 4.72  | 7.36  | 3.17  | 1.62  | 1.98 | 1.63  | 2.49  | 3.68  | 2.02 | 4.95  | 8.03  |
| A-15               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1227 | 1646  | 2585  | 2044  | 3031  | 955  | 1260  | 1473  | 1234  | 2220 | 2658  | 1418  |
| Urine Conc. (mg/L) | nd   | 2.084 | .689  | .715  | .235  | nd   | .668  | 2.454 | 1.949 | .395 | .348  | .588  |
| Amt. in Urine(mg)  | nd   | 3.43  | 1.78  | 1.46  | 0.71  | nd   | 0.84  | 3.62  | 2.40  | 0.88 | 0.93  | 0.83  |
| A-16               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 758  | 1131  | 1550  | 2211  | 1226  | 1216 | 1799  | 1269  | 1213  | 2073 | 2284  | 1433  |
| Urine Conc. (mg/L) | nd   | 1.850 | 1.000 | .225  | .321  | nd   | .079  | 2.733 | 1.613 | .774 | .490  | .663  |
| Amt. in Urine(mg)  | nd   | 2.09  | 1.55  | 0.50  | 0.39  | nd   | 0.14  | 3.47  | 1.96  | 1.60 | 1.12  | 0.95  |
| A-17               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 942  | 969   | 1454  | 2267  | 1911  | 1288 | 894   | 3414  | 966   | 1583 | 1143  | 3118  |
| Urine Conc. (mg/L) | nd   | 1.481 | 1.321 | .411  | .420  | .200 | .474  | .519  | 2.237 | .802 | .748  | .205  |
| Amt. in Urine(mg)  | nd   | 1.43  | 1.92  | 0.93  | 0.80  | 0.26 | 0.42  | 1.77  | 2.26  | 1.27 | 0.85  | 0.64  |
| A-18               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1796 | 2174  | 3496  | 2918  | 2615  | 3259 | 1500  | 2162  | 1329  | 2387 | 3677  | 2689  |
| Urine Conc. (mg/L) | nd   | .562  | .246  | .186  | .125  | .112 | .146  | 2.007 | 3.712 | .583 | .381  | .351  |
| Amt. in Urine(mg)  | nd   | 1.22  | 0.86  | 0.54  | 0.33  | 0.37 | 0.22  | 4.34  | 7.47  | 1.39 | 1.40  | 0.95  |
| A-19               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1045 | 2375  | 3591  | 2913  | 3827  | 1011 | 1359  | 1572  | 1651  | 2131 | 1499  | 2637  |
| Urine Conc. (mg/L) | nd   | .687  | .439  | .195  | nd    | .080 | nd    | 2.035 | 1.087 | .335 | .375  | 0.85  |
| Amt. in Urine(mg)  | nd   | 1.63  | 1.58  | .057  | nd    | 0.08 | nd    | 3.20  | 1.79  | 0.71 | 0.56  | 0.22  |
| A-20               |      |       |       |       |       |      |       |       |       |      |       |       |
| Urine Vol.(ml)     | 1102 | 1044  | 1375  | 1385  | 1585  | 1379 | 1497  | 1585  | 977   | 1294 | 1237  | 1420  |
| Urine Conc. (mg/L) | nd   | 1.417 | 1.652 | .938  | 1.065 | .400 | .297  | .622  | .587  | .480 | .034  | .416  |
| Amt. in Urine(mg)  | nd   | 1.48  | 2.27  | 1.30  | 1.69  | 0.55 | 0.44  | 1.05  | 0.58  | 0.62 | 0.04  | 0.59  |

\*Application day.

<sup>a</sup>Values below the 0.040 mg/L detection limit are listed as nd.<sup>b</sup>Sample lost.



Table 17. Urine Data for Injection Bar Crew Applying 2,4-D

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| B-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1673            | 1002 | 964  | 861  | 1004 | 1087 | 1180 | 1115 | 1090 | 1509 | 1267 | 1764 |
| Urine Conc.(mg/L) | nd <sup>a</sup> | .210 | .420 | .371 | .162 | .076 | .054 | .077 | .262 | .101 | .079 | .090 |
| Amt. in Urine(mg) | nd              | 0.21 | 0.41 | 0.32 | 0.16 | 0.08 | 0.06 | 0.09 | 0.29 | 0.15 | 0.10 | 0.16 |
| B-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1495            | 3280 | 2808 | 2038 | 1810 | 1411 | 1226 | 1349 | 1718 | 2445 | 1185 | 809  |
| Urine Conc.(mg/L) | nd              | nd   | .030 | nd   | nd   | 0.31 | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | 0.09 | nd   | nd   | 0.04 | nd   | nd   | nd   | nd   | nd   | nd   |
| B-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 4391            | 4498 | 5165 | 1263 | 5786 | 6091 | 2020 | 3022 | 3075 | 6246 | 1161 | 3608 |
| Urine Conc.(mg/L) | nd              | nd   | .036 | .073 | nd   | nd   | .065 | nd   | .039 | nd   | .014 | nd   |
| Amt. in Urine(mg) | nd              | nd   | 0.19 | 0.09 | nd   | nd   | 0.13 | nd   | 0.12 | nd   | 0.02 | nd   |
| B-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1910            | 1277 | 1893 | 2694 | 1153 | 1316 | 1173 | 1432 | 2461 | 3100 | 3908 | 1755 |
| Urine Conc.(mg/L) | nd              | .069 | .060 | .040 | nd   | .039 | .042 | .034 | nd   | nd   | nd   | .034 |
| Amt. in Urine(mg) | nd              | 0.09 | 0.11 | 0.11 | nd   | 0.05 | 0.05 | 0.05 | nd   | nd   | nd   | 0.06 |
| B-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1207            | 631  | 740  | 987  | 763  | 1278 | 1040 | 529  | 713  | 629  | 1305 | 905  |
| Urine Conc.(mg/L) | nd              | nd   | .066 | .037 | .041 | .051 | nd   | nd   | .042 | nd   | .024 | nd   |
| Amt. in Urine(mg) | nd              | nd   | 0.05 | 0.04 | 0.03 | 0.07 | nd   | nd   | 0.03 | nd   | 0.03 | nd   |
| B-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2377            | 1757 | 1604 | 1852 | 1809 | 1046 | 1322 | 3062 | 1833 | 1519 | 904  | 1189 |
| Urine Conc.(mg/L) | nd              | nd   | .132 | .055 | .035 | .056 | nd   | nd   | .017 | nd   | .070 | .061 |
| Amt. in Urine(mg) | nd              | nd   | 0.21 | 0.10 | 0.06 | 0.06 | nd   | nd   | 0.03 | nd   | 0.06 | 0.07 |
| B-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1154            | 1113 | 1105 | 826  | 1034 | 1296 | 1147 | 1298 | 1096 | 1273 | 1625 | 1237 |
| Urine Conc.(mg/L) | nd              | nd   | .213 | .157 | .171 | .051 | .043 | nd   | .045 | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | 0.23 | 0.13 | 0.10 | 0.07 | 0.05 | nd   | 0.05 | nd   | nd   | nd   |
| B-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2562            | 1758 | 1049 | 705  | 917  | 969  | 1069 | 1061 | 1015 | 1342 | 1273 | 1710 |
| Urine Conc.(mg/L) | nd              | .114 | .079 | .057 | .051 | .029 | .033 | nd   | .032 | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | 0.20 | 0.08 | 0.04 | 0.05 | 0.03 | 0.03 | nd   | 0.03 | nd   | nd   | nd   |
| B-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1901            | 1700 | 1824 | 1200 | 706  | 753  | 1393 | 1112 | 1369 | 2157 | 1990 | 896  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | .031 | .047 | .033 | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | 0.04 | 0.03 | 0.02 | nd   | nd   | nd   | nd   | nd   | nd   |
| B-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1604            | 1356 | 1010 | 1245 | 1218 | 1305 | 1250 | 899  | 966  | 1298 | 1418 | 1062 |
| Urine Conc.(mg/L) | nd              | .489 | .552 | .313 | .117 | .079 | .073 | .205 | .240 | .127 | .067 | .237 |
| Amt. in Urine(mg) | nd              | 0.66 | 0.56 | 0.39 | 0.14 | 0.10 | 0.09 | 0.18 | 0.23 | 0.16 | 0.10 | 0.04 |
| B-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 3032            | 1454 | 1971 | 1649 | 1079 | 1389 | 2645 | 1579 | 1156 | 960  | 2528 | 1913 |
| Urine Conc.(mg/L) | nd              | .081 | .133 | .224 | .204 | .104 | .057 | .085 | .504 | .097 | nd   | nd   |
| Amt. in Urine(mg) | nd              | 0.12 | 0.26 | 0.37 | 0.22 | 0.14 | 0.15 | 0.13 | 0.58 | 0.09 | nd   | nd   |

Table 17. (Cont.)

|                    | T-1  |      |      |      |      |      |      | T-2  |      |      |      |      |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
| B-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1832 | 898  | 894  | 721  | 954  | 868  | 1450 | 1255 | 1346 | 1004 | 610  | 1070 |
| Urine Conc. (mg/L) | nd   | .353 | .563 | .390 | .234 | .099 | .063 | .049 | .154 | .143 | .125 | .083 |
| Amt. in Urine(mg)  | nd   | 0.32 | 0.50 | 0.28 | 0.22 | 0.09 | 0.09 | 0.06 | 0.21 | 0.14 | 0.08 | 0.09 |
| B-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2228 | 1351 | 870  | 854  | 928  | 1286 | 1330 | 1131 | 1003 | 1048 | 1054 | 1522 |
| Urine Conc. (mg/L) | nd   | .247 | .339 | .329 | .257 | .222 | .124 | .167 | .291 | .210 | .177 | .079 |
| Amt. in Urine(mg)  | nd   | .33  | .29  | 0.28 | 0.24 | 0.29 | 0.16 | 0.19 | 0.29 | 0.22 | 0.19 | 0.12 |
| B-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1013 | 995  | 993  | 888  | 921  | 830  | 794  | 684  | 546  | 739  | 670  | 1158 |
| Urine Conc. (mg/L) | .036 | .111 | .109 | .207 | .066 | .041 | .049 | .049 | nd   | .035 | .030 | .026 |
| Amt. in Urine(mg)  | 0.04 | 0.11 | 0.19 | 0.18 | 0.06 | 0.03 | 0.04 | 0.03 | nd   | 0.03 | 0.02 | 0.03 |
| B-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2265 | 1997 | 1108 | 1029 | 2109 | 1376 | 937  | 1027 | 1577 | 2158 | 1862 | 1053 |
| Urine Conc. (mg/L) | nd   | .079 | .173 | .228 | .136 | .151 | .120 | .095 | .067 | .029 | .030 | .047 |
| Amt. in Urine(mg)  | nd   | 0.16 | 0.19 | 0.16 | 0.20 | 0.21 | 0.11 | 0.10 | 0.11 | 0.06 | 0.06 | 0.05 |
| B-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2012 | 1439 | 1205 | 1155 | 1147 | 1336 | 1267 | 1321 | 1194 | 1487 | 1803 | 1632 |
| Urine Conc. (mg/L) | nd   | .029 | .071 | .054 | .045 | .084 | .032 | .045 | .023 | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | 0.04 | 0.09 | 0.06 | 0.05 | 0.11 | 0.04 | 0.06 | 0.03 | nd   | nd   | nd   |
| B-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1477 | 2587 | 1041 | 1506 | 2251 | 1799 | 1868 | 2066 | 1171 | 2100 | 2569 | 1903 |
| Urine Conc. (mg/L) | nd   | nd   | .162 | .070 | .070 | .076 | .070 | .074 | .118 | .062 | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | 0.17 | 0.10 | 0.16 | 0.14 | 0.13 | 0.15 | 0.08 | 0.13 | nd   | nd   |
| B-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 3480 | 1766 | 2393 | 2572 | 1152 | 1888 | 1652 | 1332 | 1790 | 2350 | 2292 | 2047 |
| Urine Conc. (mg/L) | nd   | .136 | .361 | .379 | .421 | .256 | .106 | .151 | .151 | .068 | .048 | .045 |
| Amt. in Urine(mg)  | nd   | 0.24 | 0.86 | 0.97 | 0.48 | 0.48 | 0.17 | 0.20 | 0.27 | 0.16 | 0.11 | 0.09 |
| B-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1809 | 1319 | 1230 | 1334 | 1945 | 1796 | 1110 | 747  | 1179 | 1927 | 822  | 986  |
| Urine Conc. (mg/L) | nd   | .034 | .036 | .102 | .062 | .046 | .063 | .121 | .087 | .045 | .290 | .065 |
| Amt. in Urine(mg)  | nd   | 0.05 | 0.04 | 0.14 | 0.12 | 0.08 | 0.07 | 0.09 | 0.10 | 0.09 | 0.24 | 0.06 |
| B-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1581 | 961  | 804  | 493  | 849  | 916  | 1010 | 806  | 954  | 1302 | 789  | 942  |
| Urine Conc. (mg/L) | nd   | .078 | .116 | .062 | .064 | .065 | .064 | .070 | .053 | .044 | nd   | .169 |
| Amt. in Urine(mg)  | nd   | 0.07 | 0.09 | 0.03 | 0.05 | 0.06 | 0.07 | 0.06 | 0.05 | 0.06 | nd   | 0.16 |

\*Application day.

aValues below the 0.040 mg/L detection limit are listed are nd.

Table 18. Urine Data for Hypohatchet Crew Applying 2,4-D

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| C-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1074            | 1006 | 1894 | 657  | 553  | 826  | 725  | 1298 | 675  | 1194 | 1788 | 1795 |
| Urine Conc.(mg/L) | .340            | .665 | .452 | .946 | .567 | .376 | .291 | .140 | .300 | .231 | .157 | .580 |
| Amt. in Urine(mg) | 0.37            | 0.67 | 0.86 | 0.62 | 0.31 | 0.31 | 0.21 | 0.18 | 0.20 | 0.28 | 0.28 | 0.10 |
| C-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 3787            | 2797 | 3230 | 2092 | 1995 | 1435 | 2884 | 2695 | 2523 | 3242 | 2747 | 2829 |
| Urine Conc.(mg/L) | .194            | .717 | .781 | .991 | .661 | .724 | .230 | .248 | .272 | .176 | .113 | .084 |
| Amt. in Urine(mg) | 0.74            | 2.00 | 2.52 | 2.07 | 1.32 | 1.04 | 0.66 | 0.67 | 0.69 | 0.57 | 0.31 | 0.24 |
| C-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 943             | 891  | 1520 | 1263 | 1225 | 1031 | 1505 | 1036 | 1088 | 1267 | 1640 | 2132 |
| Urine Conc.(mg/L) | .376            | .983 | .885 | .887 | .376 | .457 | .221 | .285 | .269 | .175 | .143 | .098 |
| Amt. in Urine(mg) | 0.35            | 0.88 | 1.34 | 1.12 | 0.46 | 0.47 | 0.33 | 0.29 | 0.29 | 0.22 | 0.23 | 0.21 |
| C-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1438            | 1204 | 1028 | 1415 | 1178 | 1198 | 1083 | 1555 | 1233 | 1880 | 1941 | 1367 |
| Urine Conc.(mg/L) | .190            | .945 | 1.58 | 1.19 | .884 | .578 | .307 | .275 | .251 | .146 | .109 | .098 |
| Amt. in Urine(mg) | 0.27            | 1.14 | 1.63 | 1.68 | 1.04 | 0.69 | 0.33 | 0.43 | 0.31 | 0.27 | 0.21 | 0.13 |
| C-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1438            | 1465 | 1991 | 1501 | 1621 | 1372 | 1600 | 1314 | 1214 | 1544 | 1761 | 1286 |
| Urine Conc.(mg/L) | .144            | 1.06 | 2.93 | 2.26 | 1.02 | .561 | .351 | .253 | .187 | .171 | .091 | .081 |
| Amt. in Urine(mg) | 0.21            | 1.55 | 5.82 | 3.40 | 1.66 | 0.77 | 0.56 | 0.33 | 0.23 | 0.26 | 0.16 | 0.10 |
| C-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2488            | 1010 | 1027 | 916  | 2094 | 761  | 1036 | 1237 | 1602 | 1296 | 1090 | 1516 |
| Urine Conc.(mg/L) | .202            | 1.23 | 2.11 | 2.56 | .572 | .845 | .517 | .382 | .301 | .266 | .212 | .141 |
| Amt. in Urine(mg) | 0.50            | 1.24 | 2.17 | 2.34 | 1.20 | 0.64 | 0.54 | 0.47 | 0.48 | 0.35 | 0.23 | 0.21 |
| C-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2197            | 1607 | 2324 | 2478 | 3241 | 1547 | 1488 | 1475 | 1908 | 2119 | 1635 | 2630 |
| Urine Conc.(mg/L) | .282            | 1.72 | 1.94 | 1.93 | .798 | 1.19 | .503 | .362 | .213 | .103 | .113 | .045 |
| Amt. in Urine(mg) | 0.62            | 2.76 | 4.50 | 4.79 | 2.59 | 1.84 | 0.75 | 0.53 | 0.41 | 0.22 | 0.18 | 0.12 |
| C-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1863            | 1795 | 1660 | 1221 | 1081 | 1003 | 1056 | 1359 | 1312 | 1243 | 1362 | 974  |
| Urine Conc.(mg/L) | nd <sup>a</sup> | .360 | .437 | .477 | .239 | .131 | .120 | .359 | 1.00 | 1.30 | 1.07 | nd   |
| Amt. in Urine(mg) | nd              | 0.65 | 0.72 | 0.58 | 0.26 | 0.13 | 0.13 | 0.49 | 1.31 | 1.62 | 1.46 | nd   |
| C-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 915             | 836  | 991  | 737  | 903  | 982  | 1490 | 1238 | 1110 | 847  | 782  | 619  |
| Urine Conc.(mg/L) | nd              | .185 | .313 | .477 | .269 | .082 | .060 | .228 | .333 | .451 | .371 | .326 |
| Amt. in Urine(mg) | nd              | 0.15 | 0.31 | 0.35 | 0.24 | 0.08 | 0.09 | 0.28 | 0.37 | 0.38 | 0.29 | 0.20 |
| C-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2274            | 1364 | 1351 | 1444 | 1623 | 986  | 1232 | 1228 | 1232 | 1124 | 1511 | 1214 |
| Urine Conc.(mg/L) | nd              | .306 | .309 | .268 | .210 | .219 | .930 | .692 | 1.47 | 1.37 | .886 | .813 |
| Amt. in Urine(mg) | nd              | 0.42 | 0.42 | 0.39 | 0.34 | 0.22 | 0.11 | 0.85 | 1.81 | 1.54 | 1.34 | 0.99 |
| C-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1075            | 1101 | 898  | 1011 | 1164 | 709  | 826  | 858  | 1009 | 905  | 679  | 901  |
| Urine Conc.(mg/L) | nd              | .038 | .039 | .057 | nd   | nd   | nd   | .212 | .475 | .820 | .770 | .924 |
| Amt. in Urine(mg) | nd              | 0.04 | 0.04 | 0.06 | nd   | nd   | nd   | 0.18 | 0.48 | 0.74 | 0.52 | 0.83 |



Table 18. (Cont.)

|                    | T-1  |      |      |      |      |      | T-2  |      |      |      |      |      |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
| C-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | b    | 590  | 825  | 1260 | 832  | 1815 | 1120 | 1238 | 1303 | 954  | 1077 | 996  |
| Urine Conc. (mg/L) |      | .296 | .551 | .320 | .439 | .128 | .089 | .336 | .567 | .819 | .524 | .373 |
| Amt. in Urine(mg)  |      | 0.17 | 0.45 | 0.40 | 0.37 | 0.23 | 0.10 | 0.42 | 0.74 | 0.78 | 0.56 | 0.37 |
| C-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1786 | 2867 | 2441 | 2063 | 1049 | 2264 | 2183 | 1893 | 1560 | 1341 | 921  | 659  |
| Urine Conc. (mg/L) | nd   | .038 | .115 | .085 | .163 | .057 | .046 | nd   | nd   | nd   | .050 | nd   |
| Amt. in Urine(mg)  | nd   | 0.11 | 0.20 | 0.17 | 0.17 | 0.13 | 0.10 | nd   | nd   | nd   | 0.05 | nd   |
| C-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1978 | 1727 | 1166 | 2751 | 1322 | 797  | 1983 | 2588 | 1277 | 1327 | 1180 | 1978 |
| Urine Conc. (mg/L) | nd   | .226 | 1.16 | .368 | .145 | .142 | .082 | nd   | .474 | .554 | .414 | .122 |
| Amt. in Urine(mg)  | nd   | 0.39 | 1.35 | 1.01 | 0.19 | 0.11 | 0.16 | nd   | 0.60 | 0.74 | 0.49 | 0.24 |
| C-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1226 | 823  | 843  | 868  | 715  | 614  | 777  | 1470 | 991  | 1881 | 828  | 1162 |
| Urine Conc. (mg/L) | nd   | .737 | .631 | .410 | .189 | .136 | .072 | nd   | .241 | .316 | .259 | .260 |
| Amt. in Urine(mg)  | nd   | 0.61 | 0.53 | 0.36 | 0.14 | 0.08 | .06  | nd   | 0.29 | 0.60 | 0.21 | 0.03 |
| C-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 550  | 723  | 834  | 670  | 1089 | 615  | 802  | 618  | 1056 | 939  | 1049 | 786  |
| Urine Conc. (mg/L) | .090 | 2.66 | 5.56 | 4.22 | 2.27 | 1.40 | 1.31 | 2.39 | 4.16 | 1.94 | 1.27 | 1.69 |
| Amt. in Urine(mg)  | 0.05 | 1.92 | 4.64 | 2.83 | 2.47 | 0.86 | 1.05 | 1.48 | 4.39 | 1.82 | 1.33 | 1.33 |
| C-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 382  | 858  | 627  | 802  | 991  | 1247 | 773  | 643  | 672  | 1336 | 1111 | 759  |
| Urine Conc. (mg/L) | nd   | 2.71 | 1.52 | .973 | .303 | .112 | .078 | 1.42 | .893 | .509 | .549 | .092 |
| Amt. in Urine(mg)  | nd   | 2.33 | 0.95 | 0.78 | 0.30 | 0.14 | 0.06 | 0.91 | 0.60 | 0.68 | 0.61 | 0.07 |
| C-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2323 | 2872 | 2255 | 2424 | 2490 | 2731 | 1882 | 2651 | 1843 | 2333 | 2964 | 2562 |
| Urine Conc. (mg/L) | nd   | .488 | .993 | .919 | .659 | .249 | .170 | .321 | .423 | .236 | .139 | .164 |
| Amt. in Urine(mg)  | nd   | 1.40 | 2.24 | 2.23 | 1.64 | 0.68 | 0.32 | 0.85 | 0.79 | 0.55 | 0.41 | 0.42 |
| C-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1192 | 1140 | 1014 | 1479 | 1545 | 1712 | 1385 | 1034 | 1343 | 1088 | 1124 | 1477 |
| Urine Conc. (mg/L) | .101 | 2.28 | 3.29 | 1.14 | .479 | .263 | .188 | .841 | .782 | .606 | .356 | .170 |
| Amt. in Urine(mg)  | 0.12 | 2.60 | 3.34 | 1.68 | 0.74 | 0.45 | 0.26 | 0.87 | 1.05 | 0.66 | 0.40 | 0.25 |
| C-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1287 | 1265 | 1352 | 1308 | 1822 | 1764 | 1964 | 1032 | 1162 | 956  | 1422 | 1535 |
| Urine Conc. (mg/L) | .047 | 1.48 | 1.16 | .703 | .258 | .112 | .041 | 1.35 | 1.61 | .993 | .359 | nd   |
| Amt. in Urine(mg)  | 0.06 | 1.87 | 1.57 | 0.92 | 0.47 | 0.20 | 0.08 | 1.39 | 1.87 | 0.95 | 0.51 | nd   |

\*Application day.

aValues below the 0.040 mg/L detection limit are listed as nd.

bSample lost.

Table 19. Urine Data for Hack and Squirt Crew Applying 2,4-D

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| D-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1469            | 1206 | 2194 | 1380 | 1463 | 1604 | 1922 | 1338 | 1183 | 1564 | 1974 | 2670 |
| Urine Conc.(mg/L) | nd <sup>a</sup> | nd   | .075 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | 0.16 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1275            | 1487 | 1216 | 1193 | 868  | 602  | 975  | 944  | 756  | 915  | 984  | 335  |
| Urine Conc.(mg/L) | nd              | .067 | .080 | .108 | .094 | .079 | .062 | .115 | .038 | nd   | .046 | .044 |
| Amt. in Urine(mg) | nd              | 0.10 | 0.10 | 0.13 | 0.08 | 0.05 | 0.06 | 0.11 | 0.03 | nd   | 0.05 | 0.01 |
| D-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2191            | 2563 | 2565 | 3560 | 3290 | 1704 | 1280 | 1664 | 2059 | 3625 | 1829 | 3547 |
| Urine Conc.(mg/L) | nd              | .229 | .299 | .072 | .064 | .135 | .179 | .118 | .101 | .038 | .062 | .050 |
| Amt. in Urine(mg) | nd              | 0.59 | 0.77 | 0.26 | 0.21 | 0.23 | 0.23 | 0.20 | 0.21 | 0.14 | 0.11 | 0.18 |
| D-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1251            | 952  | 1703 | 1628 | 946  | 1176 | 847  | 1723 | 982  | 1454 | 795  | 1171 |
| Urine Conc.(mg/L) | nd              | .609 | .559 | .375 | .290 | .242 | .225 | .143 | .305 | .288 | .367 | .352 |
| Amt. in Urine(mg) | nd              | 0.58 | 0.95 | 0.61 | 0.27 | 0.28 | 0.19 | 0.25 | 0.30 | 0.42 | 0.29 | 0.41 |
| D-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1041            | 1548 | 2832 | 2104 | 2495 | 1100 | 1463 | 2008 | 1290 | 828  | 981  | 2110 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | .043 | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | 0.04 | nd   | nd   |
| D-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1163            | 1166 | 902  | 1187 | 1302 | 705  | 855  | 1029 | 845  | 1140 | 1082 | 841  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1421            | 1768 | 1975 | 1825 | 1623 | 1805 | 2225 | 1779 | 1625 | 2287 | 1972 | 2304 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | .125 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | 0.23 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 869             | 1189 | b    | 1026 | 1253 | 763  | 802  | 719  | 1099 | 1479 | 1249 | 944  |
| Urine Conc.(mg/L) | nd              | .094 |      | .147 | nd   | nd   | .094 | .219 | .207 | .094 | .069 | nd   |
| Amt. in Urine(mg) | nd              | 0.11 |      | 0.15 | nd   | nd   | 0.08 | 0.16 | 0.23 | 0.14 | 0.09 | nd   |
| D-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 684             | 790  | 950  | 1236 | 1897 | 1074 | 839  | 884  | 947  | 1482 | 1167 | 1319 |
| Urine Conc.(mg/L) | .047            | .100 | .358 | .317 | .147 | .075 | .052 | .068 | .098 | .065 | nd   | nd   |
| Amt. in Urine(mg) | 0.03            | 0.08 | 0.34 | 0.39 | 0.28 | 0.08 | 0.04 | 0.06 | 0.09 | 0.10 | nd   | nd   |
| D-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1881            | 1263 | 2373 | 1209 | 1148 | 654  | 897  | 2067 | 1764 | 888  | 1158 | 557  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | .044 | nd   | nd   | nd   | nd   | .038 | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | 0.05 | nd   | nd   | nd   | nd   | 0.03 | nd   | nd   |
| D-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1979            | 1662 | 1773 | 2552 | 2015 | 1904 | 1678 | 2730 | 2286 | 2641 | 2554 | 2478 |
| Urine Conc.(mg/L) | nd              | .038 | .096 | nd   | nd   | .047 | .040 | .042 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | 0.06 | 0.17 | nd   | nd   | 0.09 | 0.07 | 0.11 | nd   | nd   | nd   | nd   |

Table 19. (Cont.)

T-1

T-2

| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| D-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 495  | 924  | 1072 | 989  | 839  | 936  | 1277 | 983  | 1156 | 1130 | 1215 | 961  |
| Urine Conc. (mg/L) | nd   | .076 | .175 | .151 | .121 | .085 | nd   | .045 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | 0.07 | 0.19 | 0.15 | 0.10 | 0.08 | nd   | 0.04 | nd   | nd   | nd   | nd   |
| D-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 928  | 1465 | 1271 | 1068 | 1334 | 1187 | 1177 | 970  | 703  | 687  | 1082 | 1262 |
| Urine Conc. (mg/L) | .039 | .294 | .461 | .378 | .198 | .106 | .093 | .225 | .439 | .509 | .166 | .176 |
| Amt. in Urine(mg)  | 0.04 | 0.43 | 0.59 | 0.40 | 0.26 | 0.13 | 0.11 | 0.22 | 0.31 | 0.35 | 0.18 | 0.22 |
| D-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1175 | 1207 | 1413 | 881  | 1035 | 947  | 1042 | 928  | 1102 | 1728 | 1359 | 1310 |
| Urine Conc. (mg/L) | .150 | .084 | nd   | .043 | nd   | .066 | .185 | .135 | nd   | .039 | .069 | nd   |
| Amt. in Urine(mg)  | 0.18 | 0.10 | nd   | 0.04 | nd   | 0.06 | 0.19 | 0.13 | nd   | 0.07 | 0.09 | nd   |
| D-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Conc. (mg/L) | .064 | .269 | .455 | .325 | .208 | nd   | .297 | .140 | nd   | .097 | nd   | .072 |
| Amt. in Urine(mg)  | 0.06 | 0.25 | 0.35 | 0.20 | 0.24 | nd   | 0.17 | 0.07 | nd   | 0.13 | nd   | 0.04 |
| D-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 950  | 706  | 503  | 482  | 919  | 661  | 719  | 721  | 1189 | 1057 | 639  | 688  |
| Urine Conc. (mg/L) | nd   | 2.05 | 2.28 | 2.04 | 1.16 | .277 | .292 | 1.51 | 1.03 | .346 | .379 | .281 |
| Amt. in Urine(mg)  | nd   | 1.47 | 1.15 | 0.90 | 1.06 | 0.18 | 0.21 | 1.09 | 1.22 | 0.37 | 0.24 | 0.19 |
| D-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1028 | 1062 | 1008 | 1100 | 977  | 1196 | 949  | 989  | 896  | 1111 | 979  | 935  |
| Urine Conc. (mg/L) |      | 2.89 | 2.36 | 1.99 | 1.29 | .558 | .324 | .906 | .771 | .744 | .894 | .882 |
| Amt. in Urine(mg)  | 0.23 | 3.07 | 2.40 | 2.19 | 1.26 | 0.67 | 0.31 | 0.90 | 0.69 | 0.83 | 0.87 | 0.82 |
| D-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2622 | 3052 | 2653 | 2935 | 2881 | 2841 | 2617 | 2689 | 3025 | 2369 | 2392 | 3058 |
| Urine Conc. (mg/L) | nd   | .531 | .614 | .574 | .243 | .184 | .081 | .184 | .158 | .128 | .093 | .044 |
| Amt. in Urine(mg)  | nd   | 1.62 | 1.63 | 1.68 | 0.70 | 0.52 | 0.21 | 0.49 | 0.48 | 0.30 | 0.22 | 0.13 |
| D-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1766 | 920  | 801  | 1053 | 1294 | 1029 | 1222 | 1020 | 924  | 1502 | 1611 | 1272 |
| Urine Conc. (mg/L) | nd   | 3.27 | 4.10 | 1.88 | .796 | .418 | .206 | .728 | 1.38 | .619 | .327 | .170 |
| Amt. in Urine(mg)  | nd   | 3.02 | 3.28 | 1.98 | 1.03 | 0.43 | 0.25 | 0.74 | 1.28 | 0.93 | 0.53 | 0.22 |
| D-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1306 | 1037 | 1106 | 1358 | 682  | 1120 | 1071 | 1078 | 1248 | 1306 | 859  | 1013 |
| Urine Conc. (mg/L) | nd   | 1.54 | 1.37 | .913 | .689 | .288 | .092 | nd   | .265 | .209 | .129 | nd   |
| Amt. in Urine(mg)  | nd   | 1.59 | 1.51 | 1.24 | 0.47 | 0.32 | 0.10 | nd   | 0.57 | 0.27 | 0.11 | nd   |

\*Application day.

<sup>a</sup>Values below the 0.040 mg/L detection limit are listed as nd.<sup>b</sup>Sample lost.



Table 20. Urine Data for Injection Bar Crew Applying Picloram

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| B-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1673            | 1002 | 964  | 861  | 1004 | 1087 | 1180 | 1115 | 1090 | 1509 | 1267 | 1764 |
| Urine Conc.(mg/L) | nd <sup>a</sup> | .045 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .045 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1495            | 3280 | 2808 | 2038 | 1810 | 1411 | 1226 | 1349 | 1718 | 2445 | 1185 | 809  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 4391            | 4498 | 5165 | 1263 | 5786 | 6091 | 2020 | 3022 | 3075 | 6246 | 1161 | 3608 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1910            | 1277 | 1893 | 2694 | 1153 | 1316 | 1432 | 1173 | 2461 | 3100 | 3908 | 1755 |
| Urine Conc.(mg/L) | nd              | .018 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .023 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1207            | 631  | 740  | 987  | 763  | 1278 | 1040 | 529  | 713  | 629  | 1305 | 905  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2377            | 1757 | 1604 | 1852 | 1809 | 1046 | 1322 | 3062 | 1833 | 1519 | 904  | 1189 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1154            | 1113 | 1105 | 826  | 1034 | 1296 | 1147 | 1298 | 1096 | 1273 | 1625 | 1237 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2562            | 1758 | 1049 | 705  | 917  | 969  | 1069 | 1061 | 1015 | 1342 | 1273 | 1710 |
| Urine Conc.(mg/L) | nd              | .029 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .05  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1901            | 1700 | 1824 | 1200 | 706  | 753  | 1393 | 1112 | 1369 | 2157 | 1990 | 896  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1604            | 1356 | 1010 | 1245 | 1218 | 1305 | 1250 | 899  | 966  | 1298 | 1418 | 1062 |
| Urine Conc.(mg/L) | nd              | .074 | nd   | nd   | nd   | nd   | nd   | .068 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .10  | nd   | nd   | nd   | nd   | nd   | .061 | nd   | nd   | nd   | nd   |
| B-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 3032            | 1454 | 1971 | 1649 | 1079 | 1389 | 2645 | 1579 | 1156 | 960  | 2528 | 1913 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |

Table 20. (Cont.)

|                    | T-1  |      |      |      |      |      | T-2  |      |      |      |      |      |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
| B-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1832 | 898  | 894  | 721  | 954  | 868  | 1450 | 1255 | 1346 | 1004 | 610  | 1070 |
| Urine Conc. (mg/L) | nd   | .176 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .158 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2228 | 1351 | 870  | 854  | 928  | 1286 | 1330 | 1131 | 1003 | 1048 | 1054 | 1522 |
| Urine Conc. (mg/L) | nd   | .053 | nd   | nd   | nd   | nd   | nd   | .022 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .072 | nd   | nd   | nd   | nd   | nd   | .025 | nd   | nd   | nd   | nd   |
| B-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1013 | 995  | 993  | 888  | 921  | 830  | 794  | 684  | 546  | 739  | 670  | 1158 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2265 | 1997 | 1108 | 1029 | 2109 | 1376 | 937  | 1027 | 1577 | 2158 | 1862 | 1053 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2012 | 1439 | 1205 | 1155 | 1147 | 1336 | 1267 | 1321 | 1194 | 1487 | 1803 | 1632 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1477 | 2587 | 1041 | 1506 | 2251 | 1799 | 1868 | 2066 | 1171 | 2100 | 2569 | 1903 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 3480 | 1766 | 2393 | 2572 | 1152 | 1888 | 1652 | 1332 | 1790 | 2350 | 2292 | 2047 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1809 | 1319 | 1230 | 1334 | 1945 | 1796 | 1110 | 747  | 1179 | 1927 | 822  | 986  |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| B-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1581 | 961  | 804  | 493  | 849  | 916  | 1010 | 806  | 954  | 1302 | 789  | 942  |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |

\*Application day.

<sup>a</sup>Values below the 0.010 mg/L detector limit are listed as nd.

Table 21. Urine Data for Hypohatchet Crew Applying Picloram

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| C-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1074            | 1006 | 1894 | 657  | 553  | 826  | 725  | 1298 | 675  | 1194 | 1788 | 1795 |
| Urine Conc.(mg/L) | nd <sup>a</sup> | .039 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .039 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 3787            | 2797 | 3230 | 2092 | 1995 | 1435 | 2884 | 2695 | 2523 | 3242 | 2747 | 2829 |
| Urine Conc.(mg/L) | nd              | .040 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .113 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 943             | 891  | 1520 | 1263 | 1225 | 1031 | 1505 | 1036 | 1088 | 1267 | 1640 | 2132 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1438            | 1204 | 1028 | 1415 | 1178 | 1198 | 1083 | 1555 | 1233 | 1880 | 1941 | 1367 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1438            | 1465 | 1991 | 1501 | 1621 | 1372 | 1600 | 1314 | 1214 | 1544 | 1761 | 1286 |
| Urine Conc.(mg/L) | nd              | .031 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .045 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2488            | 1010 | 1027 | 916  | 2094 | 761  | 1036 | 1237 | 1602 | 1296 | 1090 | 1516 |
| Urine Conc.(mg/L) | nd              | .110 | .016 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .111 | .016 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2197            | 1607 | 2324 | 2478 | 3241 | 1547 | 1488 | 1475 | 1908 | 2119 | 1635 | 2630 |
| Urine Conc.(mg/L) | nd              | .138 | .022 | nd   | nd   | nd   | nd   | .021 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .222 | .051 | nd   | nd   | nd   | nd   | .031 | nd   | nd   | nd   | nd   |
| C-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1863            | 1795 | 1660 | 1221 | 1081 | 1003 | 1056 | 1359 | 1312 | 1243 | 1362 | 974  |
| Urine Conc.(mg/L) | nd              | .063 | .029 | nd   | nd   | nd   | nd   | .048 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .13  | .047 | nd   | nd   | nd   | nd   | .065 | nd   | nd   | nd   | nd   |
| C-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 915             | 836  | 991  | 737  | 903  | 982  | 1490 | 1238 | 1110 | 847  | 782  | 619  |
| Urine Conc.(mg/L) | nd              | .06  | .014 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .05  | .014 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2274            | 1364 | 1351 | 1444 | 1623 | 986  | 1232 | 1228 | 1232 | 1124 | 1511 | 1214 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1075            | 1101 | 898  | 1011 | 1164 | 709  | 826  | 858  | 1009 | 905  | 679  | 901  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |



Table 21. (Cont.)

T-1

T-2

| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| C-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1433 | 590  | 825  | 1260 | 832  | 1815 | 1120 | 1238 | 1303 | 954  | 1077 | 996  |
| Urine Conc. (mg/L) | nd   | .025 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .01  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1786 | 2867 | 2441 | 2063 | 1049 | 2264 | 2183 | 1893 | 1560 | 1341 | 921  | 659  |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1978 | 1727 | 1166 | 2751 | 1322 | 797  | 1983 | 2588 | 1277 | 1327 | 1180 | 1978 |
| Urine Conc. (mg/L) | nd   | .023 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .039 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1226 | 823  | 843  | 868  | 715  | 614  | 777  | 1470 | 1213 | 1881 | 828  | 1162 |
| Urine Conc. (mg/L) | nd   | .176 | nd   | nd   | nd   | nd   | nd   | nd   | .066 | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .145 | nd   | nd   | nd   | nd   | nd   | nd   | .08  | nd   | nd   | nd   |
| C-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 550  | 723  | 834  | 670  | 1089 | 615  | 802  | 618  | 1056 | 939  | 1049 | 786  |
| Urine Conc. (mg/L) | nd   | .285 | .018 | nd   | nd   | .021 | .038 | .010 | .013 | .018 | .024 | nd   |
| Amt. in Urine(mg)  | nd   | .20  | .015 | nd   | nd   | .013 | .03  | .006 | .014 | .017 | .025 | nd   |
| C-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 382  | 858  | 627  | 802  | 991  | 1247 | 773  | 643  | 672  | 1336 | 1111 | 759  |
| Urine Conc. (mg/L) | nd   | 1.59 | .043 | .023 | nd   | nd   | .016 | .836 | nd   | nd   | nd   | .058 |
| Amt. in Urine(mg)  | nd   | 1.36 | .027 | .019 | nd   | nd   | .013 | .537 | nd   | nd   | nd   | .044 |
| C-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2323 | 2872 | 2255 | 2424 | 2490 | 2731 | 1882 | 2651 | 1843 | 2333 | 2964 | 2562 |
| Urine Conc. (mg/L) | nd   | .130 | nd   | nd   | nd   | nd   | nd   | .053 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .373 | nd   | nd   | nd   | nd   | nd   | .139 | nd   | nd   | nd   | nd   |
| C-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1192 | 1140 | 1014 | 1479 | 1545 | 1712 | 1385 | 1034 | 1343 | 1088 | 1124 | 1477 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| C-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1287 | 1265 | 1352 | 1308 | 1822 | 1764 | 1964 | 1032 | 1162 | 956  | 1422 | 1535 |
| Urine Conc. (mg/L) | nd   | .127 | nd   | nd   | nd   | nd   | nd   | .165 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .16  | nd   | nd   | nd   | nd   | nd   | .17  | nd   | nd   | nd   | nd   |

\*Application day.

<sup>a</sup>Values below the 0.010 mg/L detection limit are listed as nd.

Table 22. Urine Data for Hack and Squirt Crew Applying Picloram

T-1

T-2

| Day               | 1               | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
|-------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| D-1               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1469            | 1206 | 2194 | 1380 | 1463 | 1604 | 1922 | 1338 | 1183 | 1564 | 1474 | 2670 |
| Urine Conc.(mg/L) | nd <sup>a</sup> | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-2               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1275            | 1487 | 1216 | 1193 | 868  | 602  | 975  | 944  | 756  | 915  | 984  | 335  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-3               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 2191            | 2563 | 2565 | 3560 | 3290 | 1704 | 1280 | 1664 | 2059 | 3625 | 1829 | 3547 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-4               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1251            | 952  | 1703 | 1628 | 946  | 1176 | 847  | 1723 | 982  | 1454 | 795  | 1171 |
| Urine Conc.(mg/L) | nd              | .131 | .038 | nd   | .028 | .025 | nd   | .019 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .124 | .064 | nd   | .026 | .029 | nd   | .032 | nd   | nd   | nd   | nd   |
| D-5               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1041            | 1548 | 2832 | 2104 | 2495 | 1100 | 1463 | 2008 | 1290 | 828  | 981  | 2110 |
| Urine Conc.(mg/L) | nd              | .016 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | .024 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-6               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1163            | 1166 | 902  | 1187 | 1302 | 705  | 855  | 1029 | 845  | 1140 | 1082 | 841  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-7               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1421            | 1768 | 1975 | 1825 | 1623 | 1805 | 2225 | 1779 | 1625 | 2287 | 1972 | 2304 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-8               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 898             | 1189 | 1409 | 1026 | 1253 | 763  | 802  | 719  | 1099 | 1479 | 1249 | 944  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-9               |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 684             | 790  | 950  | 1236 | 1897 | 1074 | 839  | 884  | 947  | 1482 | 1167 | 1319 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-10              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1881            | 1263 | 2373 | 1209 | 1148 | 654  | 897  | 2067 | 1764 | 888  | 1158 | 557  |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-11              |                 |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)    | 1979            | 1662 | 1773 | 2552 | 2015 | 1904 | 1678 | 2730 | 2286 | 2641 | 2554 | 2478 |
| Urine Conc.(mg/L) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg) | nd              | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |

Table 22. (Cont.)

|                    | T-1  |      |      |      |      |      | T-2  |      |      |      |      |      |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Day                | 1    | 2*   | 3    | 4    | 5    | 6    | 7    | 8*   | 9    | 10   | 11   | 12   |
| D-12               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 495  | 924  | 1072 | 989  | 839  | 936  | 1277 | 983  | 1156 | 1130 | 1215 | 961  |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-13               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 928  | 1465 | 1271 | 1068 | 1334 | 1187 | 1177 | 970  | 703  | 687  | 1082 | 1262 |
| Urine Conc. (mg/L) | nd   | .051 | .014 | nd   | nd   | nd   | nd   | .054 | .036 | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .075 | .017 | nd   | nd   | nd   | nd   | .052 | .026 | nd   | nd   | nd   |
| D-14               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1175 | 1207 | 1413 | 881  | 1035 | 947  | 1042 | 928  | 1102 | 1728 | 1359 | 1310 |
| Urine Conc. (mg/L) | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-15               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 987  | 921  | 761  | 608  | 1133 | 629  | 580  | 496  | 586  | 1372 | 846  | 553  |
| Urine Conc. (mg/L) | nd   | .101 | .052 | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .093 | .04  | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   | nd   |
| D-16               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 950  | 706  | 503  | 482  | 919  | 661  | 719  | 721  | 1189 | 1057 | 639  | 688  |
| Urine Conc. (mg/L) | nd   | .234 | .021 | nd   | nd   | nd   | nd   | .108 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .165 | .01  | nd   | nd   | nd   | nd   | .078 | nd   | nd   | nd   | nd   |
| D-17               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1028 | 1062 | 1008 | 1100 | 977  | 1196 | 949  | 989  | 896  | 1111 | 979  | 935  |
| Urine Conc. (mg/L) | nd   | .062 | .075 | nd   | nd   | nd   | nd   | .053 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .066 | .075 | nd   | nd   | nd   | nd   | .052 | nd   | nd   | nd   | nd   |
| D-18               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 2622 | 3052 | 2653 | 2935 | 2881 | 2841 | 2617 | 2689 | 3025 | 2369 | 2392 | 3058 |
| Urine Conc. (mg/L) | nd   | .207 | nd   | nd   | nd   | nd   | nd   | .041 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .632 | nd   | nd   | nd   | nd   | nd   | .11  | nd   | nd   | nd   | nd   |
| D-19               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1766 | 920  | 801  | 1053 | 1294 | 1029 | 1222 | 1020 | 924  | 1502 | 1611 | 1272 |
| Urine Conc. (mg/L) | nd   | 1.06 | .078 | .012 | nd   | .013 | nd   | .109 | .022 | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .976 | .062 | .01  | nd   | .013 | nd   | .111 | .02  | nd   | nd   | nd   |
| D-20               |      |      |      |      |      |      |      |      |      |      |      |      |
| Urine Vol.(ml)     | 1306 | 1037 | 1106 | 1358 | 682  | 1120 | 1071 | 1078 | 1248 | 1306 | 859  | 1013 |
| Urine Conc. (mg/L) | nd   | .112 | .029 | nd   | nd   | nd   | nd   | .047 | nd   | nd   | nd   | nd   |
| Amt. in Urine(mg)  | nd   | .116 | .032 | nd   | nd   | nd   | nd   | .05  | nd   | nd   | nd   | nd   |

\*Application day.

<sup>a</sup>Values below the 0.010 mg/L detector limit are listed as nd.



(Table 18) 190 of 200 samples were positive for 2,4-D. In urine from hack and squirt crewmembers 140 of 199 samples contained 2,4-D (Table 19) at detectable 0.040 mg/L levels. In contrast, of the 60 workers applying picloram, only 70 of the 720 samples contained detectable 0.010 mg/L levels (Tables 20-22).

Daily and total amounts of dichlorprop excreted by backpack crewmembers on a mg (herbicide)/kg (body weight) basis as shown in Table 23 allows a comparison of the absorbed dose during the T<sub>1</sub> and T<sub>2</sub> applications. In Tables 24-27 similar comparisons are presented for 2,4-D, and picloram information is given in Tables 28-30. The excretion curves of 2,4-D on a daily basis are presented in Figures 10 through 89. All excretion curves are plotted on the same scale for all application methods and chemicals. Irrespective of the herbicide being evaluated, the major portion excreted occurred the day of application or the day following. In the case of picloram nearly all of the excretion occurred on the application day.

#### Backpack Crew Exposure:

Compared to the other three application methods this group received the most exposure to 2,4-D. This finding is not surprising since the applicators thoroughly sprayed dense vegetation ranging from 5 to 15 feet tall. Although variation in exposure level from worker to worker is expected, only slightly over a 2-fold range was shown between the mean and the most highly exposed individual in this group. Excretion curves for both 2,4-D and dichlorprop are presented for the backpack crew which applied the Weedone 170® (a 50-50 combination of 2,4-D and dichlorprop) in Figures 10-29. Only the backpack crew

(Text continued page 147)

Table 23. Daily and total amounts of dichloroprop excreted in the urine (mg/kg body wt) of backpack workers.

| Worker<br>no. | Day   |       |       |       |       |       |       |       |       |       |       |       | Total       |              |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|--------------|
|               |       |       |       |       |       |       |       |       |       |       |       |       | T1          | T2           |
|               | 1     | 2*    | 3     | 4     | 5     | 6     | 7     | 8*    | 9     | 10    | 11    | 12    | Days<br>2-6 | Days<br>8-12 |
| A-1           | 0     | .0760 | .0315 | .0086 | .0043 | .0027 | .0025 | .0181 | .0432 | .0024 | .0074 | .0075 | .1231       | .0786        |
| 2             | 0     | .0367 | .0219 | .0045 | .0067 | .0013 | .0008 | .0077 | .0122 | .0044 | .0093 | .0072 | .0711       | .0408        |
| 3             | 0     | .0305 | .0183 | .0137 | .0107 | .0044 | .0013 | .0166 | .0083 | .0077 | .0039 | .0021 | .0766       | .0388        |
| 4             | 0     | .0241 | .0653 | .0162 | .0115 | .0069 | .0054 | .0574 | .0074 | .0063 | .0070 | .0205 | .1240       | .0986        |
| 5             | 0     | .0226 | .0151 | .0038 | .0012 | 0     | .0032 | .0294 | .0187 | .0049 | .0036 | .0020 | .0427       | .0586        |
| 6             | .0176 | .0274 | .0249 | .0094 | .0044 | .0054 | .0044 | .0333 | .0374 | .0130 | .0107 | .0044 | .0715       | .0988        |
| 7             | .0039 | .0580 | .0279 | .0209 | .0079 | .0034 | .0096 | .0133 | .0105 | .0123 | .0024 | .0053 | .1181       | .0438        |
| 8             | 0     | .0403 | .0178 | .0061 | .0038 | .0043 | .0053 | .0371 | .0131 | .0041 | .0033 | .0084 | .0723       | .0660        |
| 9             | 0     | .0307 | .0212 | .0108 | .0065 | .0029 | .0029 | .0063 | .0034 | .0102 | .0032 | .0029 | .0721       | .0260        |
| 10            | 0     | .0327 | .0215 | .0083 | .0035 | .0045 | .0040 | .0252 | .0110 | .0150 | .0073 | .0055 | .0705       | .0640        |
| 11            | .0010 | .0223 | .0143 | .0046 | .0023 | 0     | .0038 | .0105 | .0262 | .0093 | .0006 | .0021 | .0435       | .0487        |
| 12            | 0     | .0411 | .0526 | .0130 | .0072 | .0023 | .0195 | .0438 | .0106 | .0164 | .0027 | .0060 | .1162       | .0795        |
| 13            | 0     | .0331 | .0300 | .0098 | .0015 | .0025 | .0054 | .0401 | .0391 | .0025 | .0036 | .0023 | .0769       | .0876        |
| 14            | .0008 | .0536 | .0169 | .0132 | .0054 | .0142 | .0189 | .0330 | .0177 | .0037 | .0240 | .0286 | .1033       | .1070        |
| 15            | .0028 | .0322 | .0394 | .0167 | .0043 | 0     | .0202 | .0792 | .0095 | .0046 | .0092 | .0052 | .0926       | .1077        |
| 16            | .0086 | .0322 | .0267 | .0102 | .0065 | .0022 | .0032 | .0334 | .0323 | .0127 | .0093 | .0131 | .0778       | .1008        |
| 17            | 0     | .0318 | .0238 | .0096 | .0100 | .0045 | .0092 | .0547 | .0081 | .0041 | .0044 | .0115 | .0797       | .0828        |
| 18            | 0     | .0200 | .0132 | .0060 | .0055 | 0     | .0039 | .0572 | .0722 | .0168 | .0058 | .0263 | .0447       | .1783        |
| 19            | 0     | .0227 | .0157 | .0030 | .0037 | 0     | 0     | .0349 | .0059 | .0058 | .0014 | .0007 | .0451       | .0487        |
| 20            | .0071 | .0266 | .0233 | .0258 | .0299 | .0055 | .0062 | .0258 | .0227 | .0139 | .0054 | .0359 | .1111       | .1037        |
| Ave.          | .0021 | .0347 | .0260 | .0107 | .0068 | .0033 | .0070 | .0327 | .0205 | .0086 | .0062 | .0099 | .0855       | .0830        |

\*Application day

Table 24. Daily and total amounts of 2,4-D excreted during T<sub>1</sub> and T<sub>2</sub> (mg/kg) of backpack workers.

| Worker<br>no. | Day   |       |       |       |       |       |       |                    |       |       |       |       | Total          |              |
|---------------|-------|-------|-------|-------|-------|-------|-------|--------------------|-------|-------|-------|-------|----------------|--------------|
|               | Day   |       |       |       |       |       |       |                    |       |       |       |       | T <sub>1</sub> |              |
|               | 1     | 2*    | 3     | 4     | 5     | 6     | 7     | 8*                 | 9     | 10    | 11    | 12    | Days<br>2-6    | Days<br>8-12 |
| A-1           | 0     | .0903 | .0322 | .0129 | .0060 | .0029 | .0011 | .0372              | .0442 | .0151 | .0104 | .0048 | .1443          | .1117        |
| 2             | 0     | .0488 | .0196 | .0054 | .0068 | .0013 | 0     | .0132              | .0097 | .0081 | .0053 | .0040 | .0819          | .0403        |
| 3             | .0211 | .0394 | .0266 | .0205 | .0110 | .0078 | .0251 | .0468 <sup>a</sup> | .0234 | .0092 | .0035 | .0024 | .1055          | .0853        |
| 4             | 0     | .0202 | .0443 | .0125 | .0108 | .0073 | .0068 | .0630              | .0203 | .0047 | .0118 | .0140 | .0951          | .1138        |
| 5             | 0     | .0138 | .0241 | .0081 | .0053 | .0023 | .0021 | .0178              | .0237 | .0139 | .0030 | .0021 | .0536          | .0605        |
| 6             | .0009 | .0188 | .0168 | .0077 | .0073 | .0030 | .0019 | .0290              | .0241 | .0065 | .0054 | .0015 | .0536          | .0665        |
| 7             | 0     | .0406 | .0361 | .0267 | .0084 | .0035 | .0057 | .0172              | .0217 | .0067 | .0048 | .0024 | .1153          | .0528        |
| 8             | 0     | .0236 | .0103 | .0053 | .0053 | .0046 | .0035 | .0268              | .0465 | .0160 | .0084 | .0143 | .0491          | .1091        |
| 9             | .0013 | .0177 | .0185 | .0108 | .0083 | .0037 | .0039 | .0102              | .0097 | .0090 | .0018 | .0018 | .0590          | .0325        |
| 10            | 0     | .0136 | .0187 | .0116 | .0053 | .0039 | .0048 | .0162              | .0326 | .0310 | .0102 | .0096 | .0531          | .0996        |
| 11            | 0     | .0130 | .0107 | .0085 | .0036 | 0     | .0019 | .0198              | .0164 | .0104 | .0004 | .0027 | .0358          | .0497        |
| 12            | .0089 | .0262 | .0324 | .0168 | .0084 | .0036 | .0162 | .0343              | .0203 | .0169 | .0055 | .0075 | .0874          | .0845        |
| 13            | 0     | .0263 | .0390 | .0123 | .0023 | .0023 | .0068 | .0373              | .0260 | .0072 | .0103 | .0041 | .0822          | .0849        |
| 14            | 0     | .0460 | .0717 | .0309 | .0158 | .0193 | .0159 | .0243              | .0359 | .0197 | .0483 | .0783 | .1837          | .2065        |
| 15            | 0     | .0422 | .0219 | .0180 | .0087 | 0     | .0103 | .0445              | .0295 | .0108 | .0114 | .0102 | .0908          | .1064        |
| 16            | 0     | .0227 | .0168 | .0054 | .0042 | 0     | .0015 | .0376              | .0213 | .0174 | .0122 | .0103 | .0491          | .0988        |
| 17            | 0     | .0191 | .0256 | .0124 | .0107 | .0035 | .0056 | .0236              | .0302 | .0170 | .0114 | .0085 | .0713          | .0907        |
| 18            | 0     | .0192 | .0135 | .0085 | .0052 | .0058 | .0035 | .0682              | .1175 | .0219 | .0220 | .0149 | .0522          | .2445        |
| 19            | 0     | .0225 | .0218 | .0079 | 0     | .0011 | 0     | .0441              | .0247 | .0098 | .0077 | .0030 | .0533          | .0893        |
| 20            | 0     | .0155 | .0238 | .0136 | .0177 | .0058 | .0046 | .0110              | .0060 | .0065 | .0004 | .0062 | .0764          | .0301        |
| Ave.          | .0016 | .0290 | .0263 | .0128 | .0076 | .0041 | .0061 | .0302              | .0292 | .0128 | .0097 | .0102 | .0876          | .0980        |

\*Application day



Table 25. Daily and total amounts of 2,4-D excreted in the urine (mg/kg) of injection bar workers.

| Worker<br>no. | Day   |       |       |       |       |       |       |       |       |       |       |       | Total             |                    |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------|--------------------|
|               | 1     | 2*    | 3     | 4     | 5     | 6     | 7     | 8*    | 9     | 10    | 11    | 12    | T1<br>Days<br>2-6 | T2<br>Days<br>8-12 |
|               |       |       |       |       |       |       |       |       |       |       |       |       |                   |                    |
| B-1           | 0     | .0021 | .0041 | .0032 | .0016 | .0008 | .0006 | .0009 | .0029 | .0015 | .0010 | .0016 | .0118             | .0079              |
| 2             | 0     | 0     | .0015 | 0     | 0     | .0007 | 0     | 0     | 0     | 0     | 0     | 0     | .0022             | 0                  |
| 3             | 0     | 0     | .0018 | .0009 | 0     | 0     | .0012 | 0     | .0011 | 0     | .0002 | 0     | .0027             | .0013              |
| 4             | 0     | .0009 | .0011 | .0011 | 0     | .0005 | .0005 | .0005 | 0     | 0     | 0     | .0006 | .0036             | .0011              |
| 5             | 0     | 0     | .0007 | .0005 | .0004 | .0009 | 0     | 0     | .0004 | 0     | .0004 | 0     | .0025             | .0008              |
| 6             | 0     | 0     | .0028 | .0013 | .0008 | .0008 | 0     | 0     | .0004 | 0     | .0008 | .0009 | .0057             | .0021              |
| 7             | 0     | 0     | .0026 | .0015 | .0012 | .0008 | .0006 | 0     | .0006 | 0     | 0     | 0     | .0061             | .0006              |
| 8             | 0     | .0033 | .0013 | .0007 | .0008 | .0005 | .0005 | 0     | .0005 | 0     | 0     | 0     | .0066             | .0005              |
| 9             | 0     | 0     | 0     | .0006 | .0005 | .0003 | 0     | 0     | 0     | 0     | 0     | 0     | .0014             | 0                  |
| 10            | 0     | .0083 | .0071 | .0049 | .0018 | .0013 | .0011 | .0013 | .0029 | .0020 | .0013 | .0005 | .0234             | .0080              |
| 11            | 0     | .0016 | .0036 | .0051 | .0030 | .0019 | .0021 | .0018 | .0079 | .0012 | 0     | 0     | .0152             | .0109              |
| 12            | 0     | .0037 | .0058 | .0033 | .0026 | .0010 | .0010 | .0007 | .0024 | .0016 | .0009 | .0010 | .0164             | .0066              |
| 13            | 0     | .0039 | .0035 | .0033 | .0029 | .0035 | .0019 | .0023 | .0035 | .0026 | .0023 | .0014 | .0171             | .0121              |
| 14            | .0006 | .0017 | .0030 | .0028 | .0009 | .0005 | .0006 | .0005 | 0     | .0005 | .0003 | .0005 | .0089             | .0018              |
| 15            | 0     | .0020 | .0023 | .0020 | .0025 | .0026 | .0014 | .0012 | .0014 | .0007 | .0007 | .0006 | .0014             | .0046              |
| 16            | 0     | .0005 | .0011 | .0007 | .0006 | .0013 | .0005 | .0007 | .0004 | 0     | 0     | 0     | .0042             | .0011              |
| 17            | 0     | 0     | .0021 | .0013 | .0020 | .0018 | .0016 | .0019 | .0010 | .0016 | 0     | 0     | .0072             | .0045              |
| 18            | 0     | .0027 | .0095 | .0108 | .0053 | .0053 | .0019 | .0022 | .0030 | .0018 | .0012 | .0010 | .0336             | .0092              |
| 19            | 0     | .0006 | .0005 | .0018 | .0015 | .0010 | .0009 | .0012 | .0013 | .0012 | .0031 | .0008 | .0054             | .0076              |
| 20            | 0     | .0009 | .0012 | .0004 | .0007 | .0008 | .0009 | .0008 | .0007 | .0008 | 0     | .0021 | .0040             | .0044              |
| Ave.          | 0     | .0016 | .0027 | .0024 | .0014 | .0013 | .0009 | .0008 | .0015 | .0008 | .0006 | .0006 | .0095             | .0043              |

\*Application day

Table 26. Daily and total amounts of 2,4-D excreted in the urine (mg/kg body wt) of hypohatchet workers.

| Worker no.             | Day   |       |       |       |       |       |       |       |       |       |       |       | Total                         |                                |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------------------|--------------------------------|
|                        | 1     | 2*    | 3     | 4     | 5     | 6     | 7     | 8*    | 9     | 10    | 11    | 12    | T <sub>1</sub><br>Days<br>2-6 | T <sub>2</sub><br>Days<br>8-12 |
|                        |       |       |       |       |       |       |       |       |       |       |       |       |                               |                                |
| C-1                    | .0049 | .0090 | .0115 | .0083 | .0041 | .0041 | .0028 | .0024 | .0027 | .0037 | .0037 | .0013 | .0370                         | .0138                          |
| 2                      | .0110 | .0296 | .0373 | .0306 | .0195 | .0154 | .0098 | .0099 | .0102 | .0084 | .0046 | .0036 | .1324                         | .0367                          |
| 3                      | .0047 | .0118 | .0180 | .0150 | .0062 | .0063 | .0044 | .0039 | .0039 | .0030 | .0031 | .0028 | .0573                         | .0167                          |
| 4                      | .0035 | .0147 | .0210 | .0217 | .0134 | .0089 | .0043 | .0055 | .0040 | .0035 | .0027 | .0017 | .0797                         | .0174                          |
| 5                      | .0031 | .0230 | .0866 | .0506 | .0247 | .0115 | .0083 | .0049 | .0034 | .0039 | .0024 | .0015 | .1964                         | .0161                          |
| 6                      | .0055 | .0136 | .0238 | .0256 | .0131 | .0070 | .0059 | .0052 | .0053 | .0038 | .0025 | .0023 | .0831                         | .0191                          |
| 7                      | .0099 | .0440 | .0718 | .0764 | .0413 | .0294 | .0120 | .0085 | .0065 | .0035 | .0029 | .0019 | .2629                         | .0233                          |
| 8                      | 0     | .0075 | .0083 | .0067 | .0030 | .0015 | .0015 | .0057 | .0152 | .0188 | .0169 | 0     | .0270                         | .0566                          |
| 9                      | 0     | .0020 | .0041 | .0047 | .0032 | .0011 | .0012 | .0037 | .0049 | .0051 | .0039 | .0027 | .0151                         | .0203                          |
| 10                     | 0     | .0050 | .0050 | .0046 | .0041 | .0026 | .0013 | .0101 | .0216 | .0183 | .0160 | .0118 | .0213                         | .0778                          |
| 11                     | 0     | .0005 | .0005 | .0008 | 0     | 0     | 0     | .0023 | .0062 | .0096 | .0067 | .0108 | .0018                         | .0356                          |
| 12                     | 0     | .0027 | .0070 | .0063 | .0058 | .0036 | .0016 | .0066 | .0116 | .0123 | .0088 | .0058 | .0254                         | .0451                          |
| 13                     | 0     | .0016 | .0040 | .0024 | .0024 | .0019 | .0014 | 0     | 0     | 0     | .0007 | 0     | .0123                         | .0007                          |
| 14                     | 0     | .0044 | .0153 | .0114 | .0022 | .0012 | .0018 | 0     | .0068 | .0084 | .0055 | .0027 | .0345                         | .0234                          |
| 15                     | 0     | .0069 | .0060 | .0041 | .0016 | .0009 | .0007 | 0     | .0033 | .0068 | .0024 | .0003 | .0195                         | .0128                          |
| 16                     | .0005 | .0192 | .0464 | .0283 | .0247 | .0086 | .0105 | .0148 | .0439 | .0182 | .0133 | .0133 | .1272                         | .1035                          |
| 17                     | 0     | .0321 | .0131 | .0107 | .0041 | .0019 | .0008 | .0125 | .0083 | .0094 | .0084 | .0010 | .0619                         | .0396                          |
| 18                     | 0     | .0162 | .0260 | .0259 | .0190 | .0079 | .0038 | .0099 | .0092 | .0064 | .0048 | .0049 | .0950                         | .0352                          |
| 19                     | .0014 | .0302 | .0387 | .0195 | .0086 | .0052 | .0030 | .0101 | .0122 | .0077 | .0046 | .0029 | .1022                         | .0375                          |
| 20                     | .0008 | .0236 | .0198 | .0116 | .0059 | .0025 | .0010 | .0175 | .0236 | .0120 | .0064 | 0     | .0634                         | .0595                          |
| Ave. for workers 1-7   | .0061 | .0208 | .0386 | .0326 | .0175 | .0118 | .0068 | .0058 | .0051 | .0043 | .0031 | .0022 | .1213                         | .0204                          |
| Ave. for workers 8-15  | 0     | .0038 | .0063 | .0051 | .0028 | .0016 | .0012 | .0036 | .0087 | .0099 | .0076 | .0043 | .0196                         | .0340                          |
| Ave. for workers 16-20 | .0005 | .0243 | .0192 | .0187 | .0125 | .0052 | .0038 | .0130 | .0195 | .0107 | .0075 | .0044 | .0901                         | .0592                          |
| Total Ave.             | .0023 | .0149 | .0232 | .0182 | .0103 | .0061 | .0038 | .0067 | .0101 | .0081 | .0060 | .0036 | .0848                         | .0395                          |

\*Application day

Table 27. Daily and total amounts of 2,4-D excreted in the urine (mg/kg body wt) of hack and squirt workers.

| Worker no.            | Day   |       |       |       |       |       |       |       |       |       |       |       | Total                      |                             |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------------------------|-----------------------------|
|                       | 1     | 2*    | 3     | 4     | 5     | 6     | 7     | 8*    | 9     | 10    | 11    | 12    | T <sub>1</sub><br>Days 2-6 | T <sub>2</sub><br>Days 8-12 |
|                       |       |       |       |       |       |       |       |       |       |       |       |       |                            |                             |
| D-1                   | 0     | 0     | .0024 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | .0024                      | 0                           |
| 2                     | 0     | .0014 | .0014 | .0018 | .0011 | .0007 | .0008 | .0015 | .0004 | 0     | .0007 | .0001 | .0064                      | .0027                       |
| 3                     | 0     | .0062 | .0081 | .0027 | .0022 | .0024 | .0024 | .0021 | .0022 | .0015 | .0012 | .0019 | .0216                      | .0089                       |
| 4                     | 0     | .0067 | .0110 | .0070 | .0031 | .0032 | .0022 | .0029 | .0035 | .0048 | .0033 | .0047 | .0310                      | .0192                       |
| 5                     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | .0001 | 0     | 0     | 0                          | .0001                       |
| 6                     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                          | 0                           |
| 7                     | 0     | 0     | 0     | .0025 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | .0025                      | 0                           |
| 8                     | 0     | .0011 | .0020 | .0015 | 0     | 0     | .0009 | .0016 | .0023 | .0014 | .0009 | 0     | .0046                      | .0062                       |
| 9                     | .0004 | .0010 | .0041 | .0046 | .0033 | .0010 | .0005 | .0007 | .0011 | .0012 | 0     | 0     | .0140                      | .0030                       |
| 10                    | 0     | 0     | 0     | 0     | .0007 | 0     | 0     | 0     | 0     | .0004 | 0     | 0     | .0007                      | .0004                       |
| 11                    | 0     | .0006 | .0002 | 0     | 0     | .0009 | .0007 | .0001 | 0     | 0     | 0     | 0     | .0017                      | .0001                       |
| 12                    | 0     | .0008 | .0023 | .0018 | .0012 | .0010 | 0     | .0005 | 0     | 0     | 0     | 0     | .0071                      | .0005                       |
| 13                    | .0004 | .0040 | .0055 | .0038 | .0024 | .0012 | .0010 | .0020 | .0029 | .0032 | .0017 | .0021 | .0169                      | .0119                       |
| 14                    | .0023 | .0013 | 0     | .0005 | 0     | .0008 | .0024 | .0016 | 0     | .0009 | .0011 | 0     | .0026                      | .0036                       |
| 15                    | .0009 | .0039 | .0054 | .0031 | .0037 | 0     | .0026 | .0011 | 0     | .0020 | 0     | .0006 | .0161                      | .0037                       |
| 16                    | 0     | .0157 | .0125 | .0106 | .0115 | .0020 | .0023 | .0118 | .0132 | .0040 | .0026 | .0021 | .0523                      | .0337                       |
| 17                    | .0034 | .0451 | .0352 | .0322 | .0185 | .0098 | .0046 | .0132 | .0101 | .0122 | .0128 | .0120 | .1408                      | .0603                       |
| 18                    | 0     | .0188 | .0189 | .0195 | .0081 | .0060 | .0024 | .0057 | .0056 | .0035 | .0026 | .0015 | .0713                      | .0189                       |
| 19                    | 0     | .0350 | .0380 | .0229 | .0119 | .0050 | .0029 | .0086 | .0148 | .0108 | .0061 | .0026 | .1128                      | .0429                       |
| 20                    | 0     | .0200 | .0190 | .0156 | .0059 | .0040 | .0013 | 0     | .0072 | .0034 | .0014 | 0     | .0645                      | .0120                       |
| Ave. of workers 1-15  | .0003 | .0018 | .0028 | .0020 | .0012 | .0007 | .0009 | .0009 | .0008 | .0010 | .0006 | .0006 | .0085                      | .0040                       |
| Ave. of workers 16-20 | .0007 | .0269 | .0247 | .0202 | .0112 | .0054 | .0027 | .0079 | .0102 | .0068 | .0051 | .0036 | .0887                      | .0342                       |
| Total Ave.            | .0004 | .0081 | .0083 | .0065 | .0037 | .0019 | .0014 | .0027 | .0031 | .0025 | .0017 | .0014 | .0288                      | .0122                       |

\*Application day



Table 28. Daily and total amounts of picloram excreted in the urine (ug/kg<sup>b</sup> body wt) of injection bar workers.

| Worker<br>no.           | Day |       |   |   |   |   |   |       |   |    |    |    | Total <sup>a</sup> |                |
|-------------------------|-----|-------|---|---|---|---|---|-------|---|----|----|----|--------------------|----------------|
|                         | 1   | 2*    | 3 | 4 | 5 | 6 | 7 | 8*    | 9 | 10 | 11 | 12 | T <sub>1</sub>     | T <sub>2</sub> |
| B-1                     | 0   | 0.451 | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0.451              | 0              |
| 2                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 3                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 4                       | 0   | 0.024 | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0.024              | 0              |
| 5                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 6                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 7                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 8                       | 0   | 0.816 | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0.816              | 0              |
| 9                       | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 10                      | 0   | 1.26  | 0 | 0 | 0 | 0 | 0 | 0.767 | 0 | 0  | 0  | 0  | 1.26               | 0.767          |
| 11                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 12                      | 0   | 1.83  | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 1.83               | 0              |
| 13                      | 0   | 0.857 | 0 | 0 | 0 | 0 | 0 | 0.297 | 0 | 0  | 0  | 0  | 0.857              | 0.297          |
| 14                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 15                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 16                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 17                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 18                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 19                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| 20                      | 0   | 0     | 0 | 0 | 0 | 0 | 0 | 0     | 0 | 0  | 0  | 0  | 0                  | 0              |
| Ave. daily<br>excretion | 0   | 0.262 | 0 | 0 | 0 | 0 | 0 | 0.053 | 0 | 0  | 0  | 0  | 0.262              | 0.053          |

<sup>a</sup>Values include the amount excreted on the spray day and the 4 days following.

<sup>b</sup>Note picloram data are expressed as ug/kg body weight.

\*Application day

Table 29. Daily and total amounts of picloram excreted in the urine (ug/kg<sup>b</sup> body wt) of hypohatchet workers.

| Worker no.                             | Day |       |       |       |   |       |       |       |       |       |       |       | Total <sup>a</sup> |                |
|--|-----|-------|-------|-------|---|-------|-------|-------|-------|-------|-------|-------|--------------------|----------------|
|  | 1   | 2*    | 3     | 4     | 5 | 6     | 7     | 8*    | 9     | 10    | 11    | 12    | T <sub>1</sub>     | T <sub>2</sub> |
| C-1                                    | 0   | 0.521 | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.521              | 0              |
| 2                                      | 0   | 1.67  | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1.67               | 0              |
| 3                                      | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 4                                      | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 5                                      | 0   | 2.16  | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 2.16               | 0              |
| 6                                      | 0   | 1.26  | 0.175 | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1.44               | 0              |
| 7                                      | 0   | 3.54  | 0.813 | 0     | 0 | 0     | 0     | 0.494 | 0     | 0     | 0     | 0     | 4.35               | 0.494          |
| 8                                      | 0   | 1.51  | 0.545 | 0     | 0 | 0     | 0     | 0.753 | 0     | 0     | 0     | 0     | 2.05               | 0.753          |
| 9                                      | 0   | 0.668 | 0.187 | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.855              | 0              |
| 10                                     | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 11                                     | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 12                                     | 0   | 0.157 | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.157              | 0              |
| 13                                     | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 14                                     | 0   | 0.441 | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0.441              | 0              |
| 15                                     | 0   | 1.64  | 0     | 0     | 0 | 0     | 0     | 0     | 0.904 | 0     | 0     | 1.64  | 0.904              | 0              |
| 16                                     | 0   | 2.00  | 0.150 | 0     | 0 | 0.130 | 0.300 | 0.060 | 0.140 | 0.170 | 0.250 | 0     | 2.28               | 0.920          |
| 17                                     | 0   | 18.7  | 0.372 | 0.262 | 0 | 0     | 0.179 | 7.40  | 0     | 0     | 0     | 0.606 | 19.33              | 8.18           |
| 18                                     | 0   | 4.32  | 0     | 0     | 0 | 0     | 0     | 1.61  | 0     | 0     | 0     | 0     | 4.32               | 1.61           |
| 19                                     | 0   | 0     | 0     | 0     | 0 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0                  | 0              |
| 20                                     | 0   | 2.01  | 0     | 0     | 0 | 0     | 0     | 2.14  | 0     | 0     | 0     | 0     | 2.01               | 2.14           |
| Ave. daily excretion for workers 1-7   | 0   | 1.31  | 0.141 | 0     | 0 | 0     | 0     | 0.071 | 0     | 0     | 0     | 0     | 1.45               | 0.071          |
| Ave. daily excretion for workers 8-15  | 0   | 0.552 | 0.092 | 0     | 0 | 0     | 0     | 0.094 | 0.113 | 0     | 0     | 0     | 0.644              | 0.207          |
| Ave. daily excretion for workers 16-20 | 0   | 5.40  | 0.110 | 0.052 | 0 | 0.026 | 0.096 | 2.24  | 0.028 | 0.034 | 0.050 | 0.121 | 5.59               | 2.57           |
| Total ave. daily excretion             | 0   | 2.03  | 0.114 | 0.013 | 0 | 0.007 | 0.024 | 0.623 | 0.052 | 0.009 | 0.013 | 0.030 | 2.17               | 0.750          |

<sup>a</sup>Values include the amount excreted on the spray day and the 4 days following.

<sup>b</sup>Note picloram data are expressed as ug/kg body weight.

\*Application day

Table 30. Daily and total amounts of picloram excreted in the urine (ug/kg<sup>b</sup> body wt) of hack and squirt crew members.

| Worker no.                             | Day |       |       |        |       |       |   |       |       |    |    |      | Total <sup>a</sup> |                |
|--|-----|-------|-------|--------|-------|-------|---|-------|-------|----|----|------|--------------------|----------------|
|  | 1   | 2*    | 3     | 4      | 5     | 6     | 7 | 8*    | 9     | 10 | 11 | 12   | T <sub>1</sub>     | T <sub>2</sub> |
| D-1                                    | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 2                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 3                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 4                                      | 0   | 1.43  | 0.738 | 0      | 0.300 | 0.335 | 0 | 0.370 | 0     | 0  | 0  | 0    | 2.80               | 0.370          |
| 5                                      | 0   | 0.297 | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0.297              | 0              |
| 6                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 7                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 8                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 9                                      | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 10                                     | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 11                                     | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 12                                     | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 13                                     | 0   | 0.703 | 0.159 | 0      | 0     | 0     | 0 | 0.487 | 0.244 | 0  | 0  | 0    | 0.860              | 0.731          |
| 14                                     | 0   | 0     | 0     | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 0                  | 0              |
| 15                                     | 0   | 1.44  | 0.620 | 0      | 0     | 0     | 0 | 0     | 0     | 0  | 0  | 0    | 2.06               | 0              |
| 16                                     | 0   | 1.79  | 0.109 | 0      | 0     | 0     | 0 | 0.846 | 0     | 0  | 0  | 0    | 1.89               | 0.846          |
| 17                                     | 0   | 0.969 | 1.10  | 0      | 0     | 0     | 0 | 0.764 | 0     | 0  | 0  | 0    | 2.07               | 0.764          |
| 18                                     | 0   | 7.32  | 0     | 0      | 0     | 0     | 0 | 1.27  | 0     | 0  | 0  | 0    | 7.32               | 1.27           |
| 19                                     | 0   | 11.3  | 0.718 | 0.116  | 0     | 0.151 | 0 | 1.29  | 0.232 | 0  | 0  | 0    | 12.3               | 1.52           |
| 20                                     | 0   | 1.46  | 0.403 | 0      | 0     | 0     | 0 | 0.629 | 0     | 0  | 0  | 0    | 1.86               | 0.629          |
| Ave. daily excretion for workers 1-15  | 0   | 0.258 | 0.101 | 0      | 0.020 | 0.022 | 0 | 0.057 | 0.016 | 0  | 0  | 0    | 0.401              | 0.073          |
| Ave. daily excretion for workers 16-20 | 0   | 4.57  | 0.466 | 0.023  | 0     | 0.030 | 0 | 0.960 | 0.046 | 0  | 0  | 0    | 5.09               | 1.25           |
| Total ave. daily excretion             | 0   | 1.34  | 0.192 | 0.0006 | 0.015 | 0.024 | 0 | 0.283 | 0.024 | 0  | 0  | 0.09 | 1.57               | 0.368          |

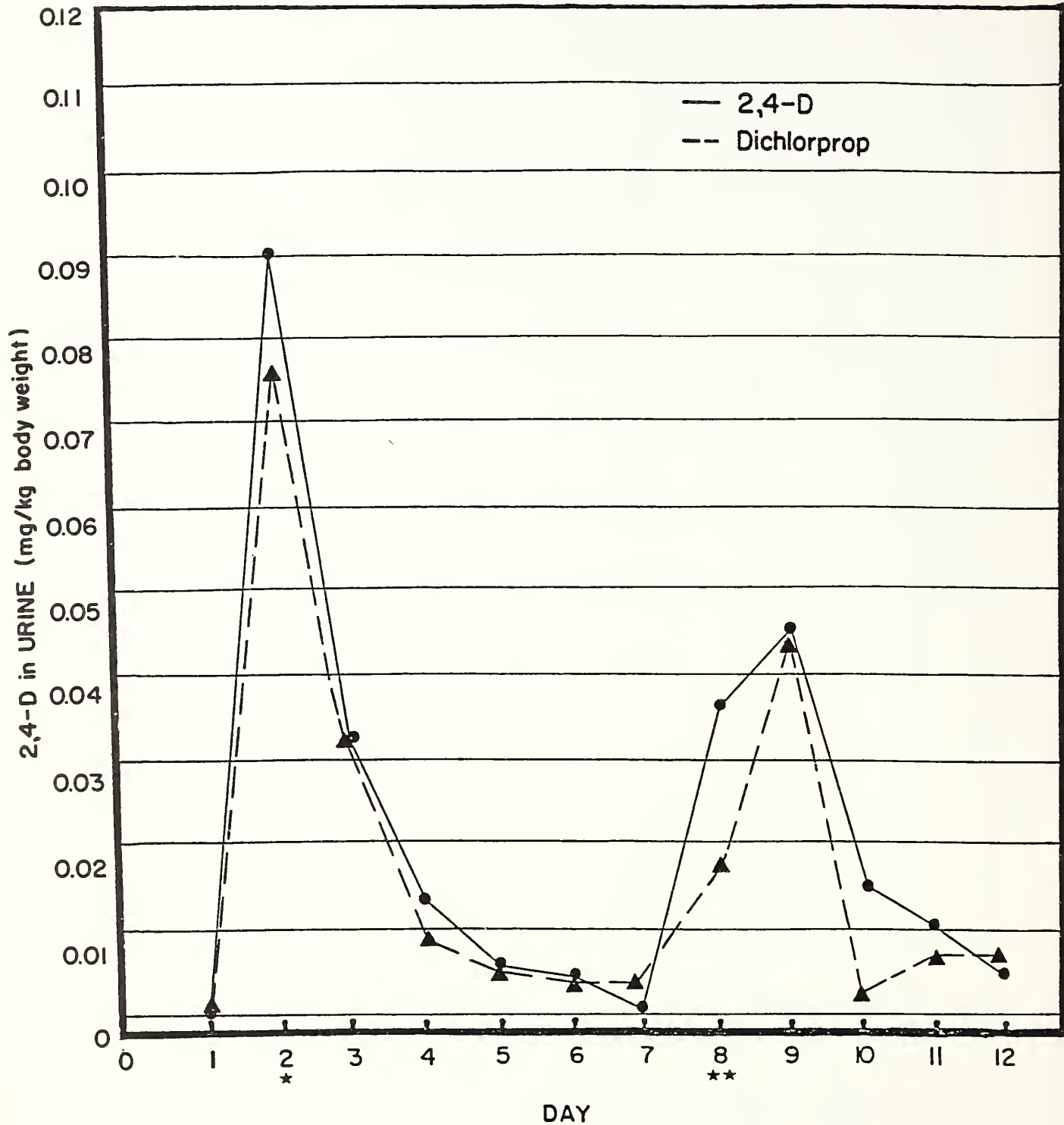
<sup>a</sup>Values include the amount excreted on the spray day and the 4 days following.

<sup>b</sup>Note picloram data are expressed as ug/kg body weight.

\*Application day

## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals

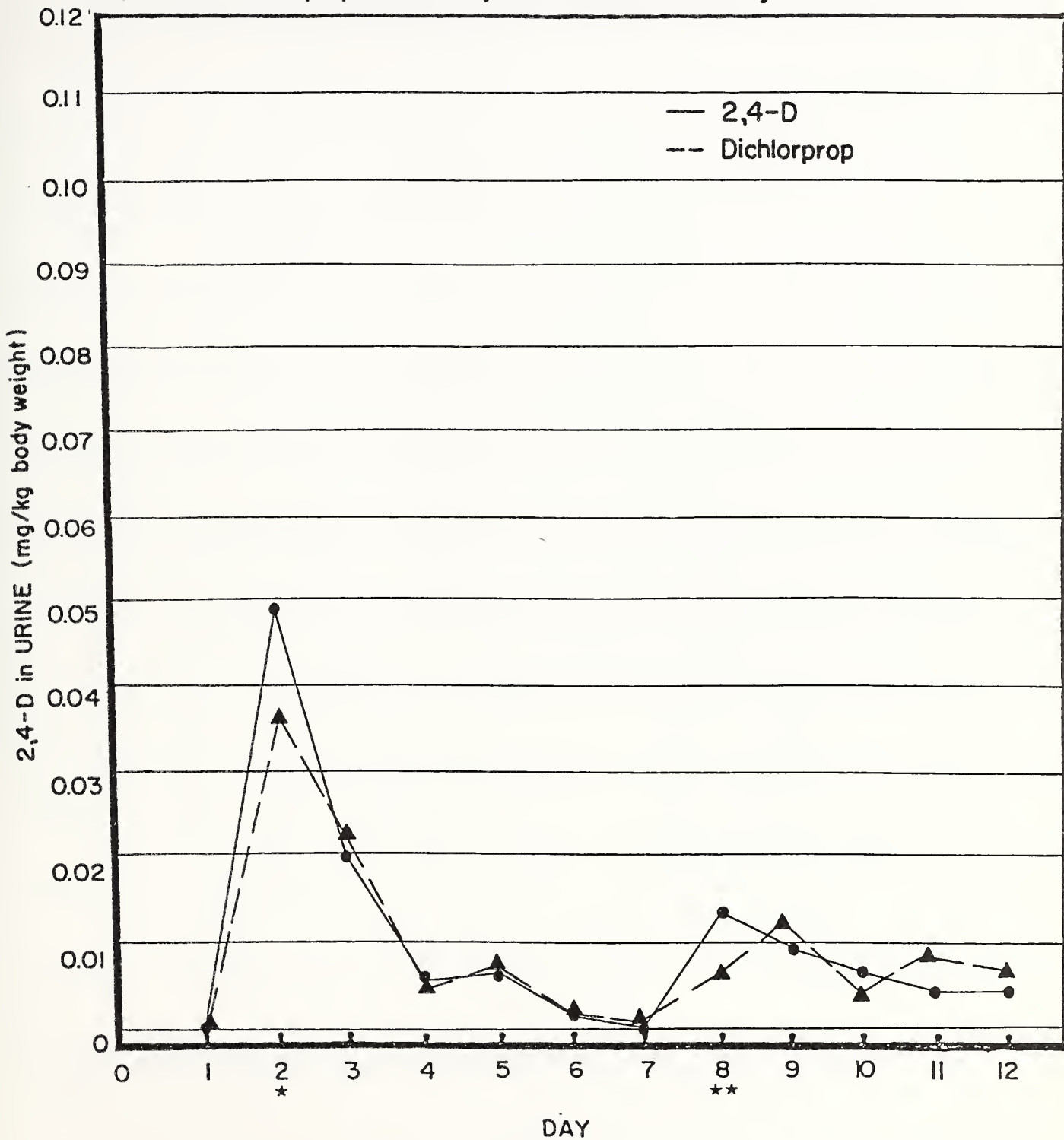


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Interval



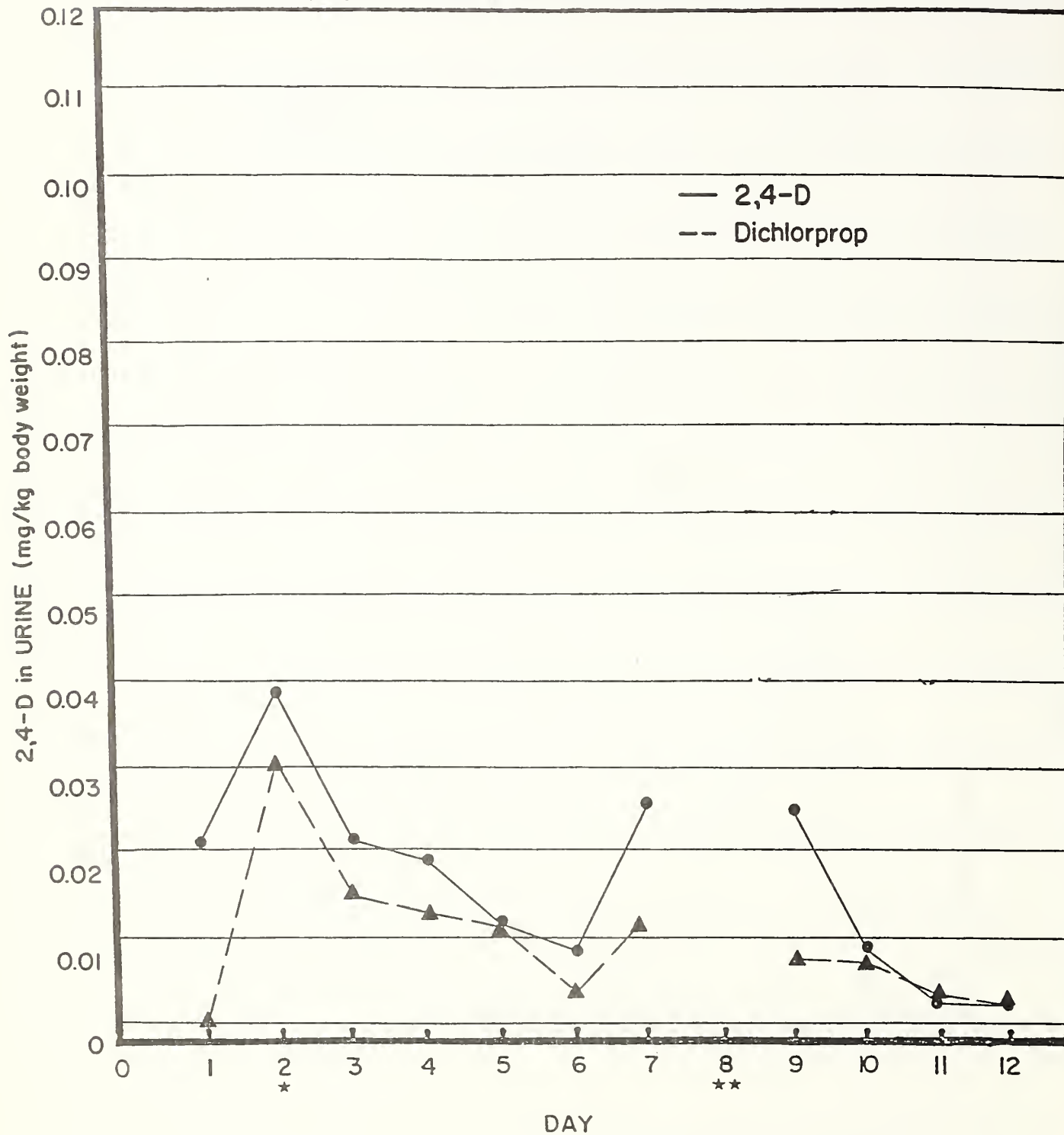
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals



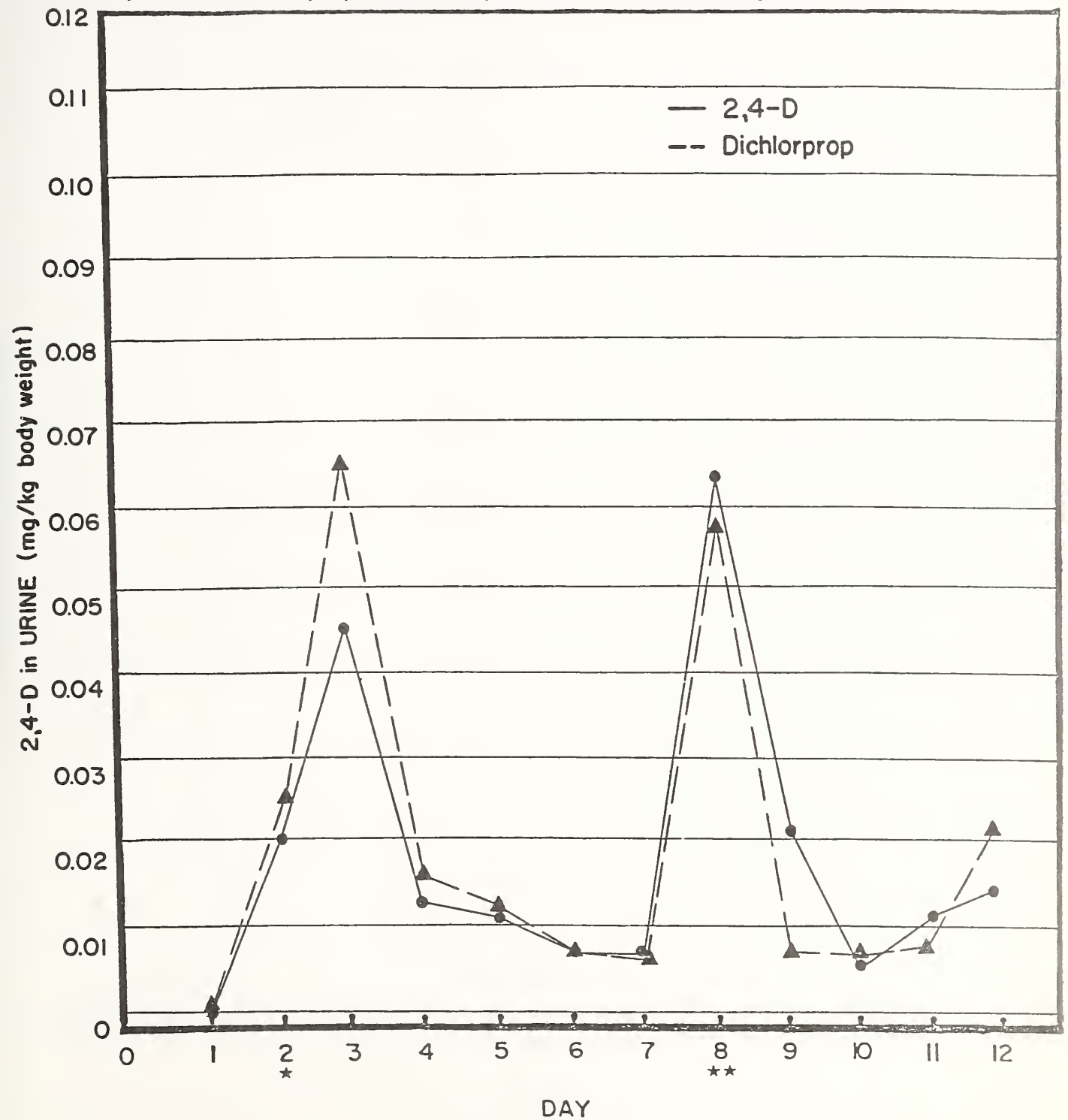
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals

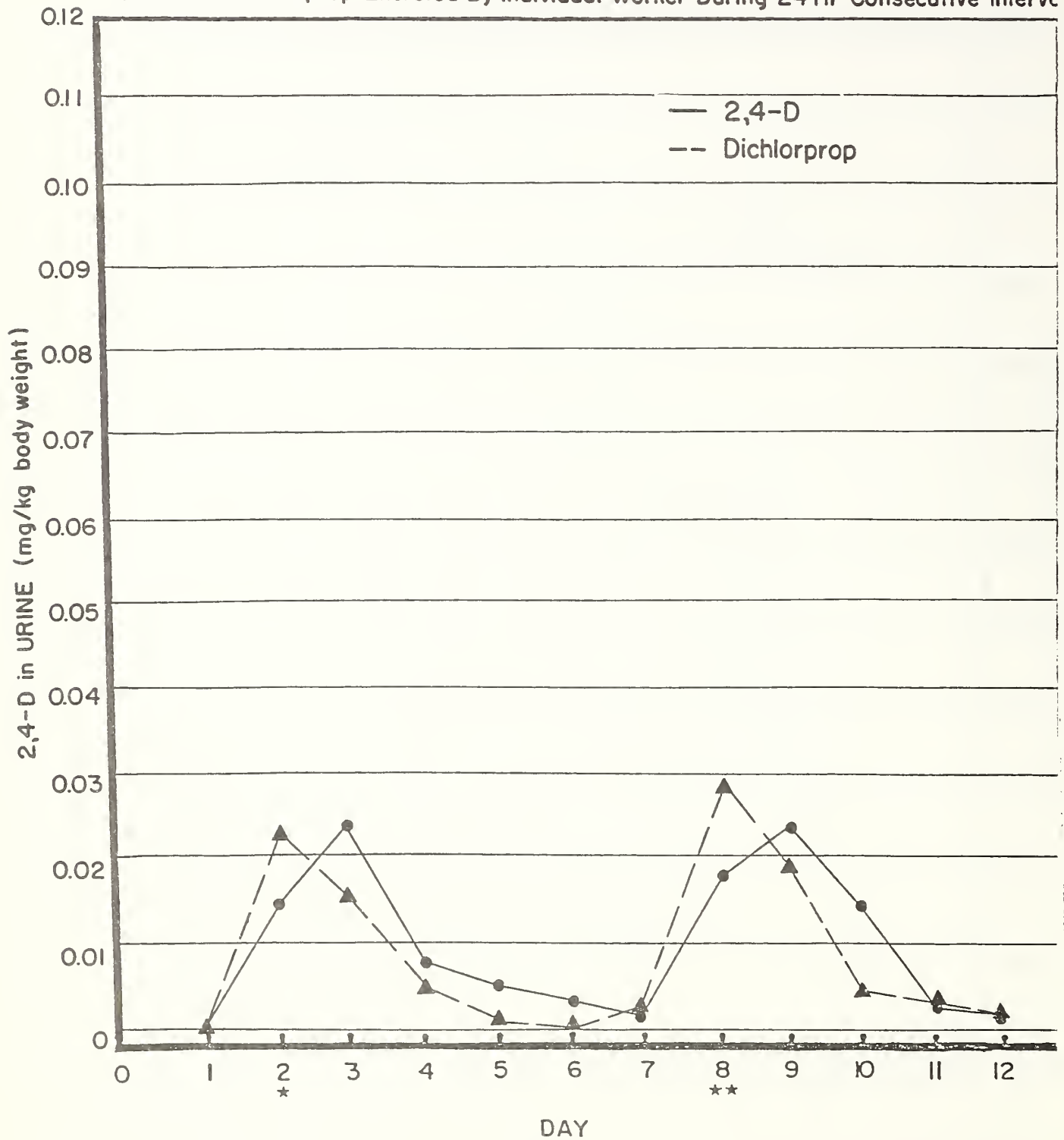


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervc

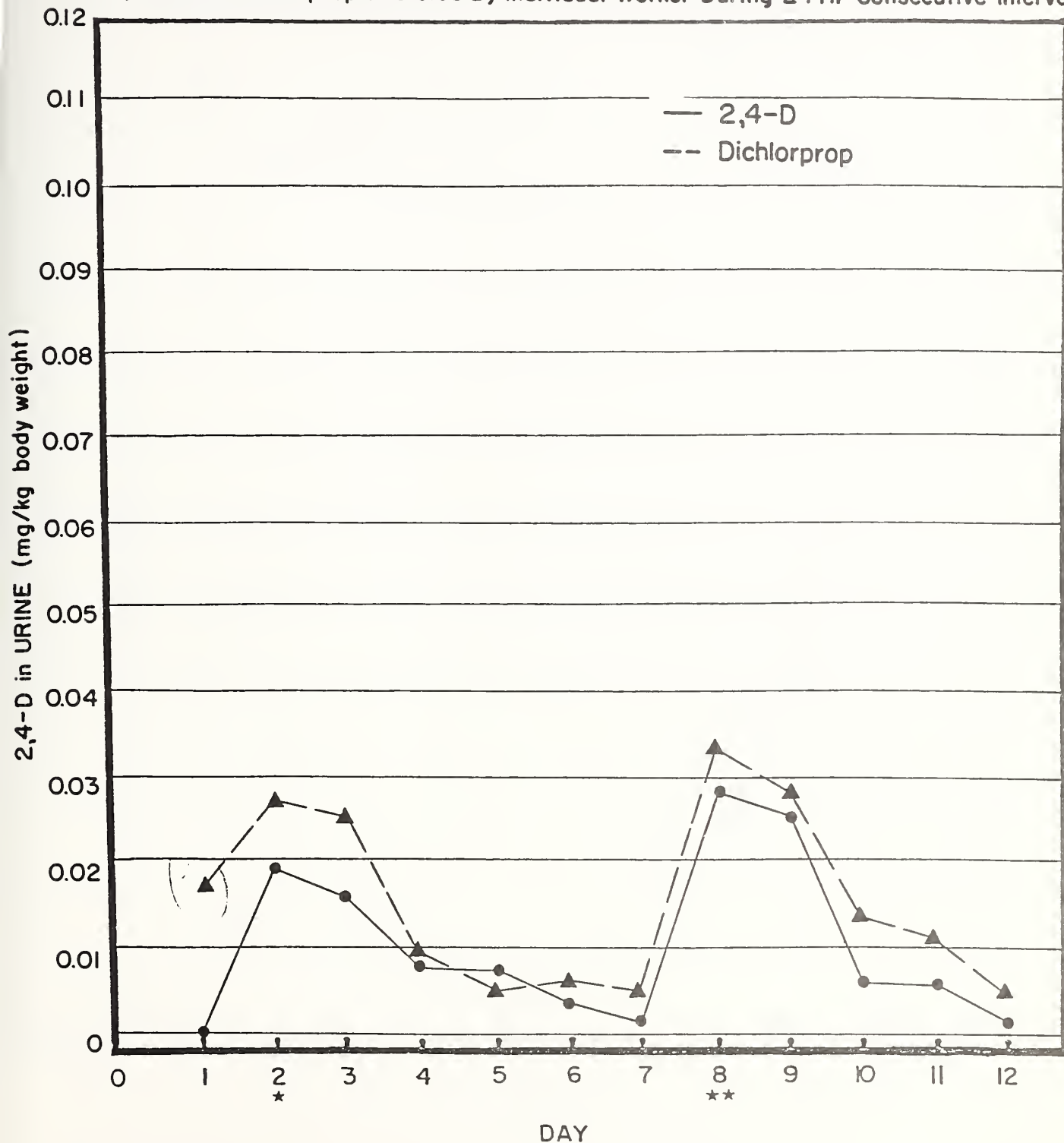


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

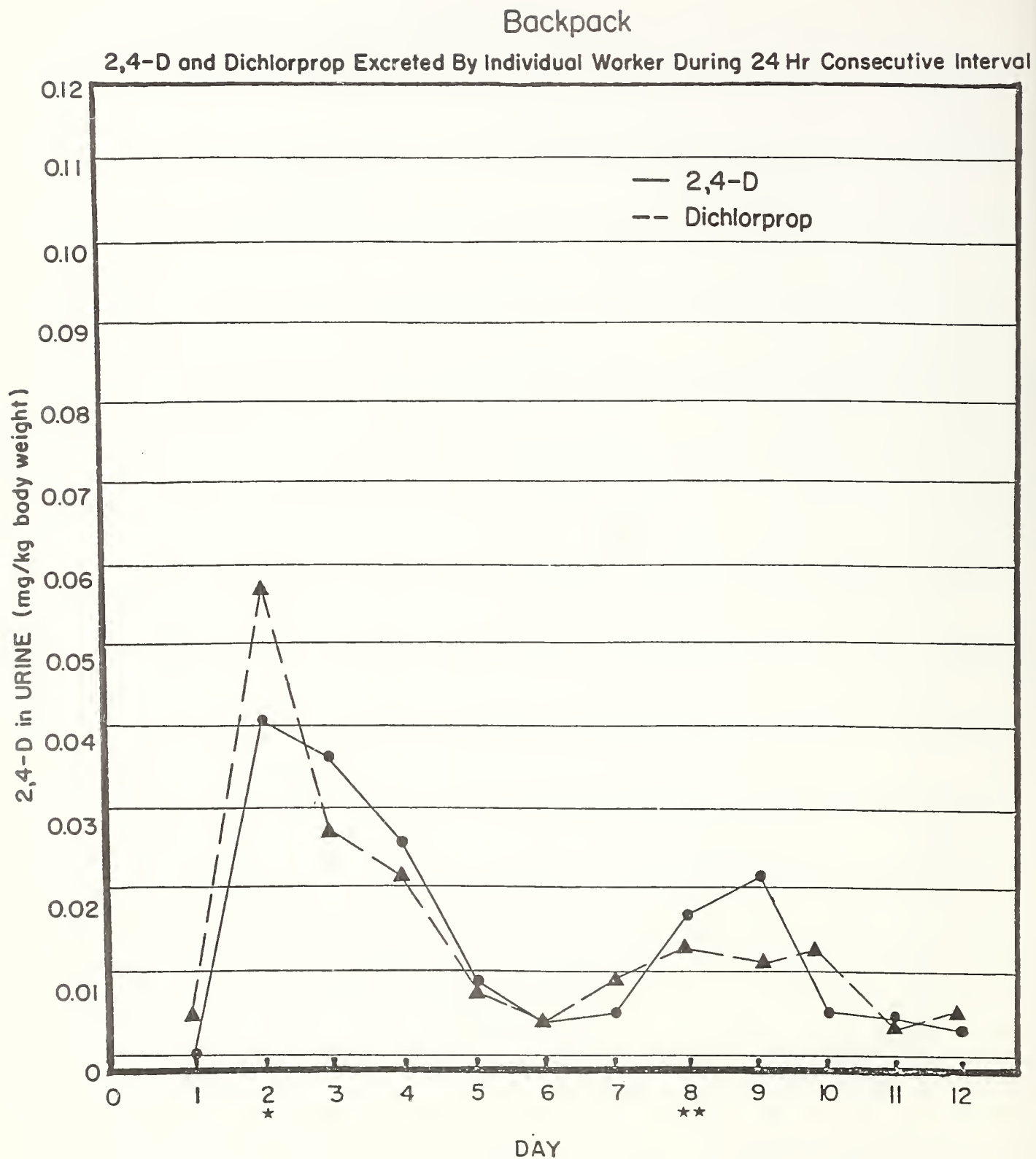
## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Interval



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

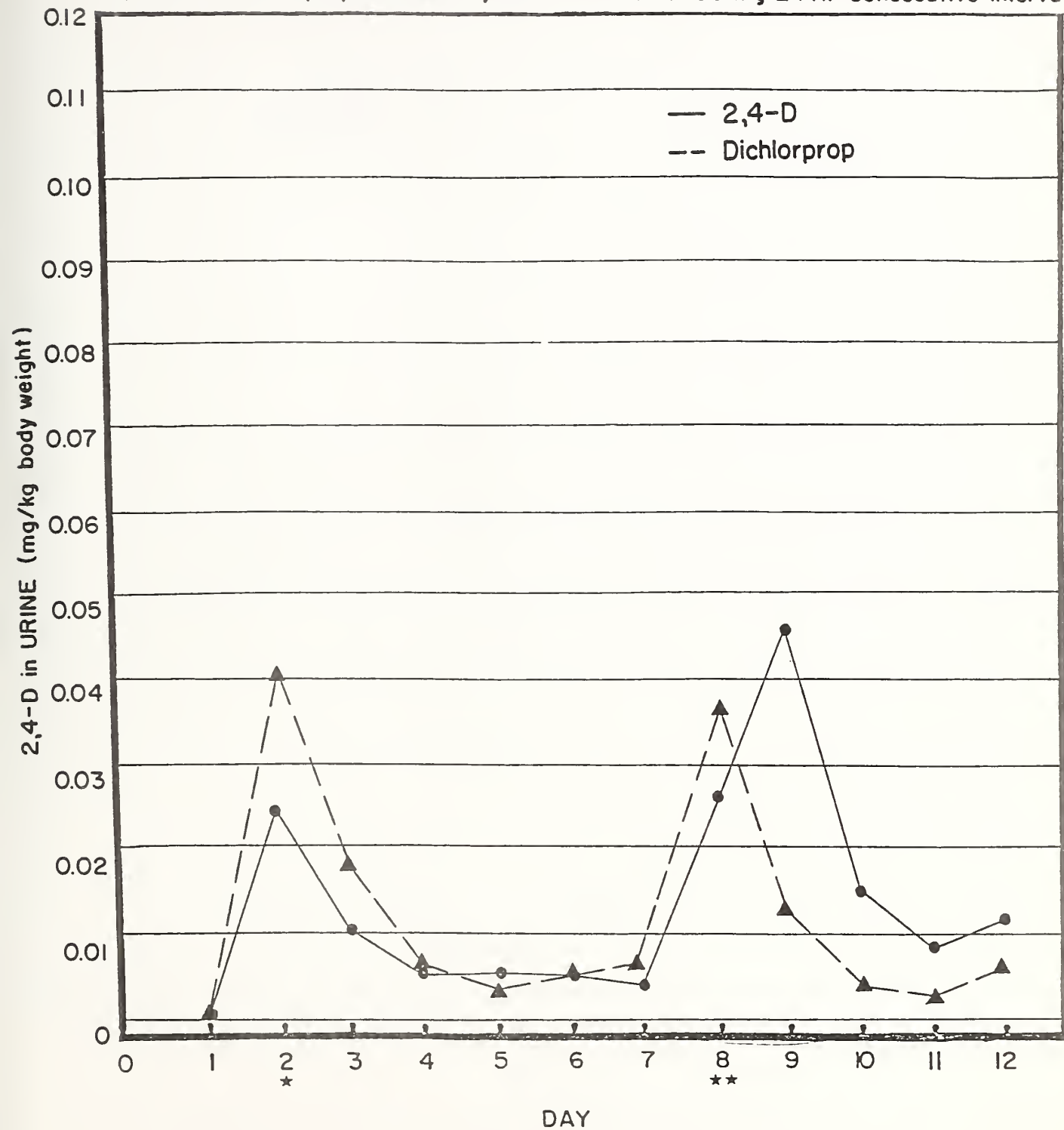


\* Treatment 1 - Ordinary precautions observed

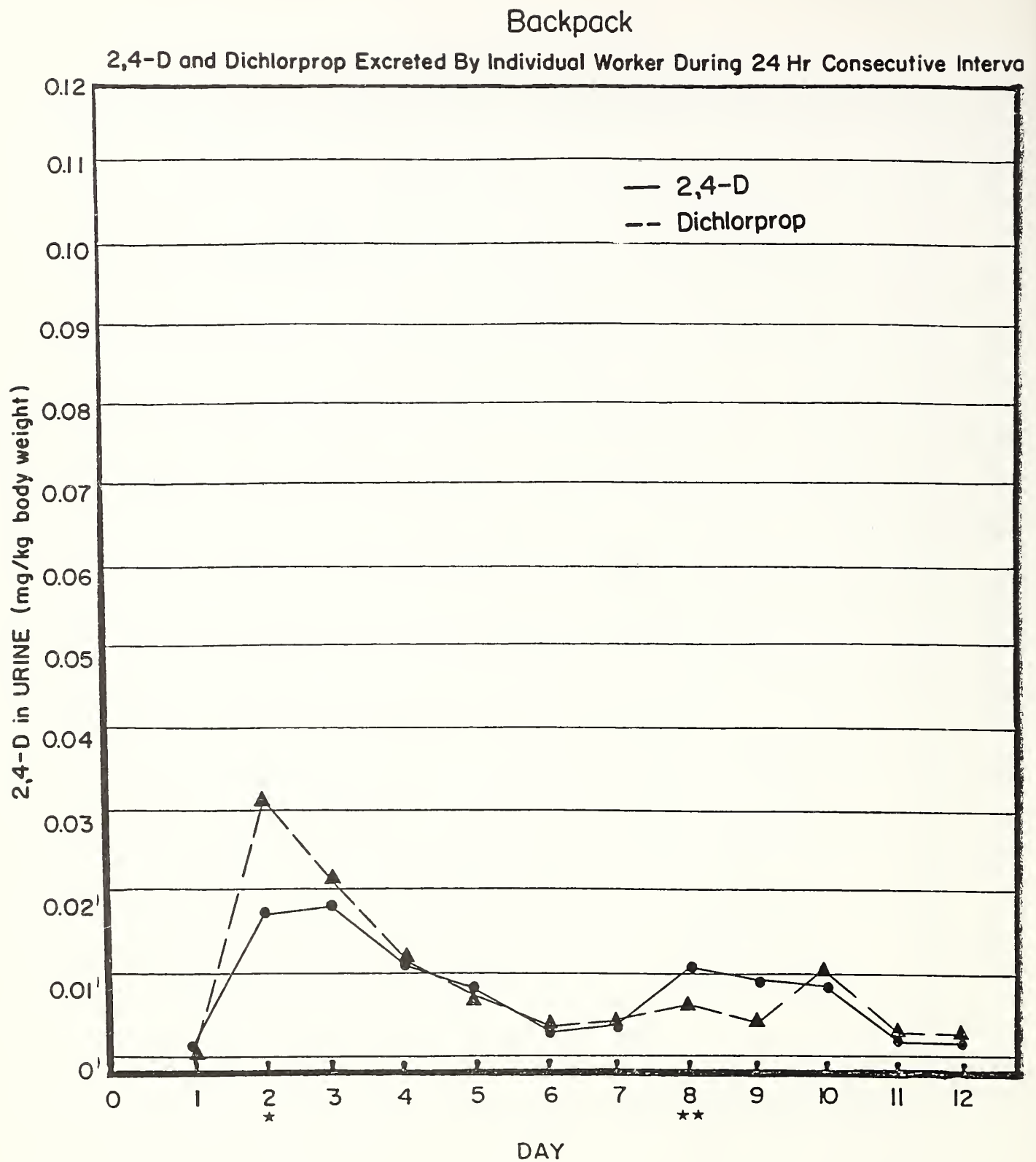
\*\* Treatment 2 - Special precautions observed

## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals

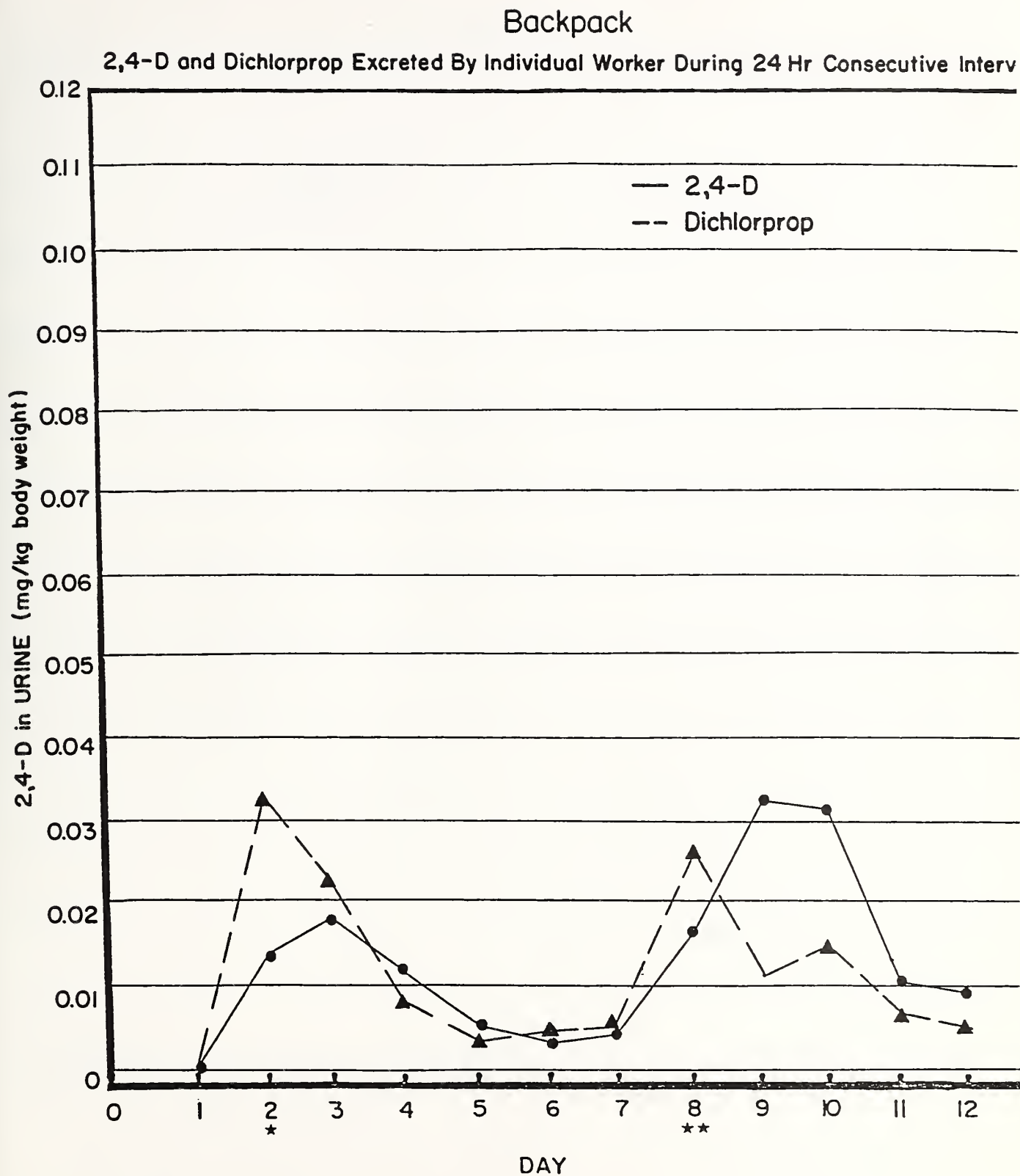




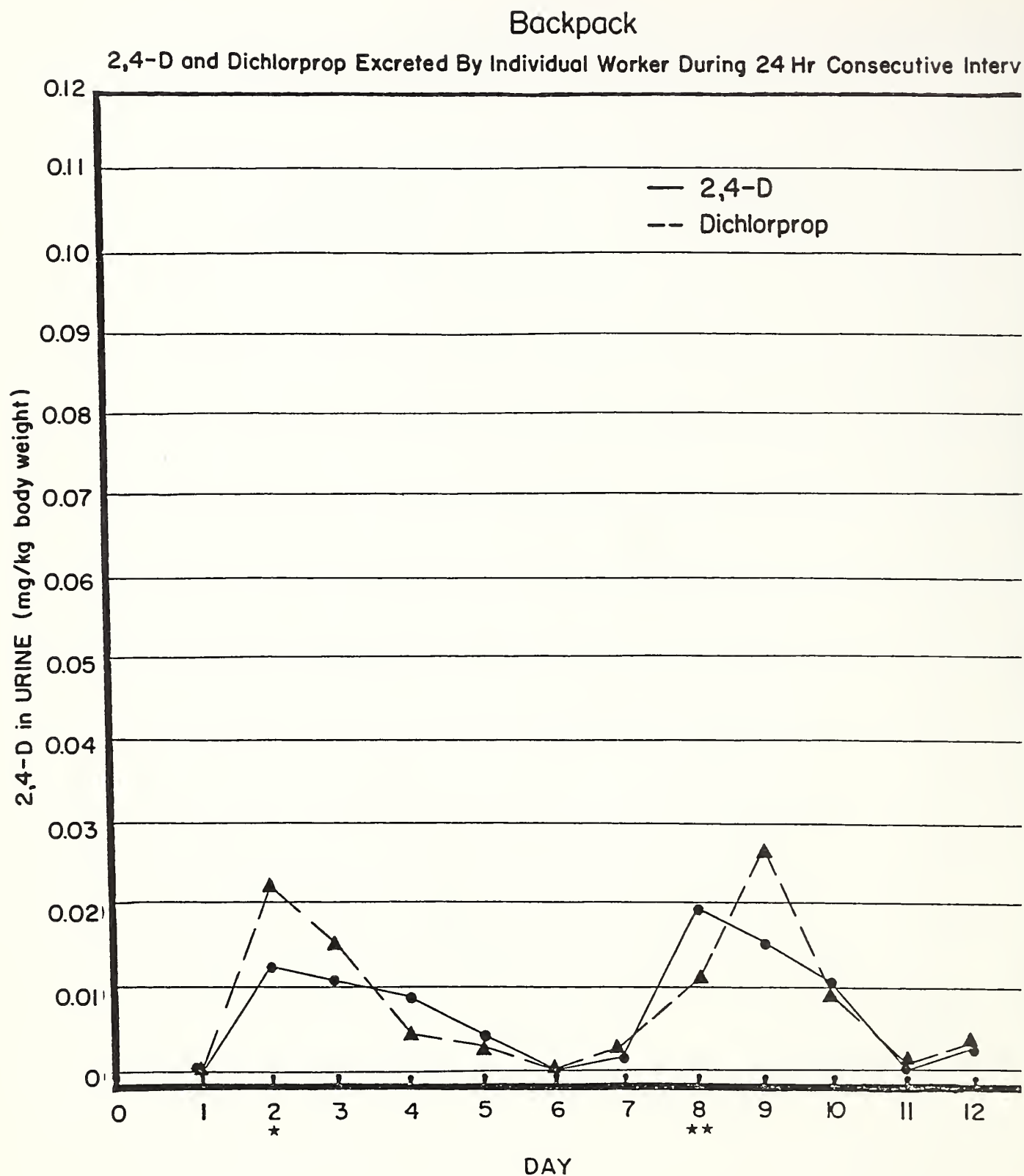


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed  
\*\* Treatment 2 - Special precautions observed

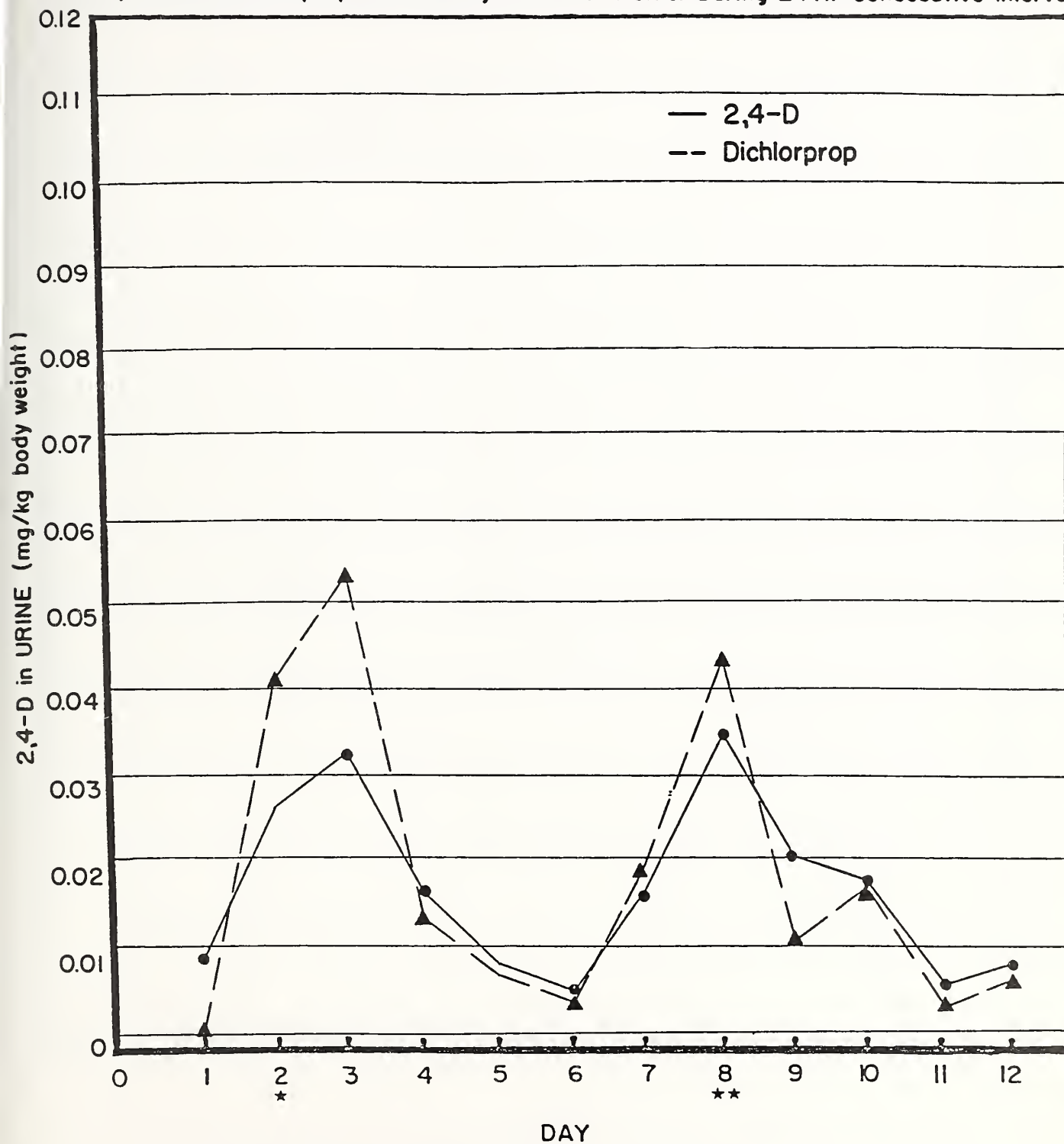


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

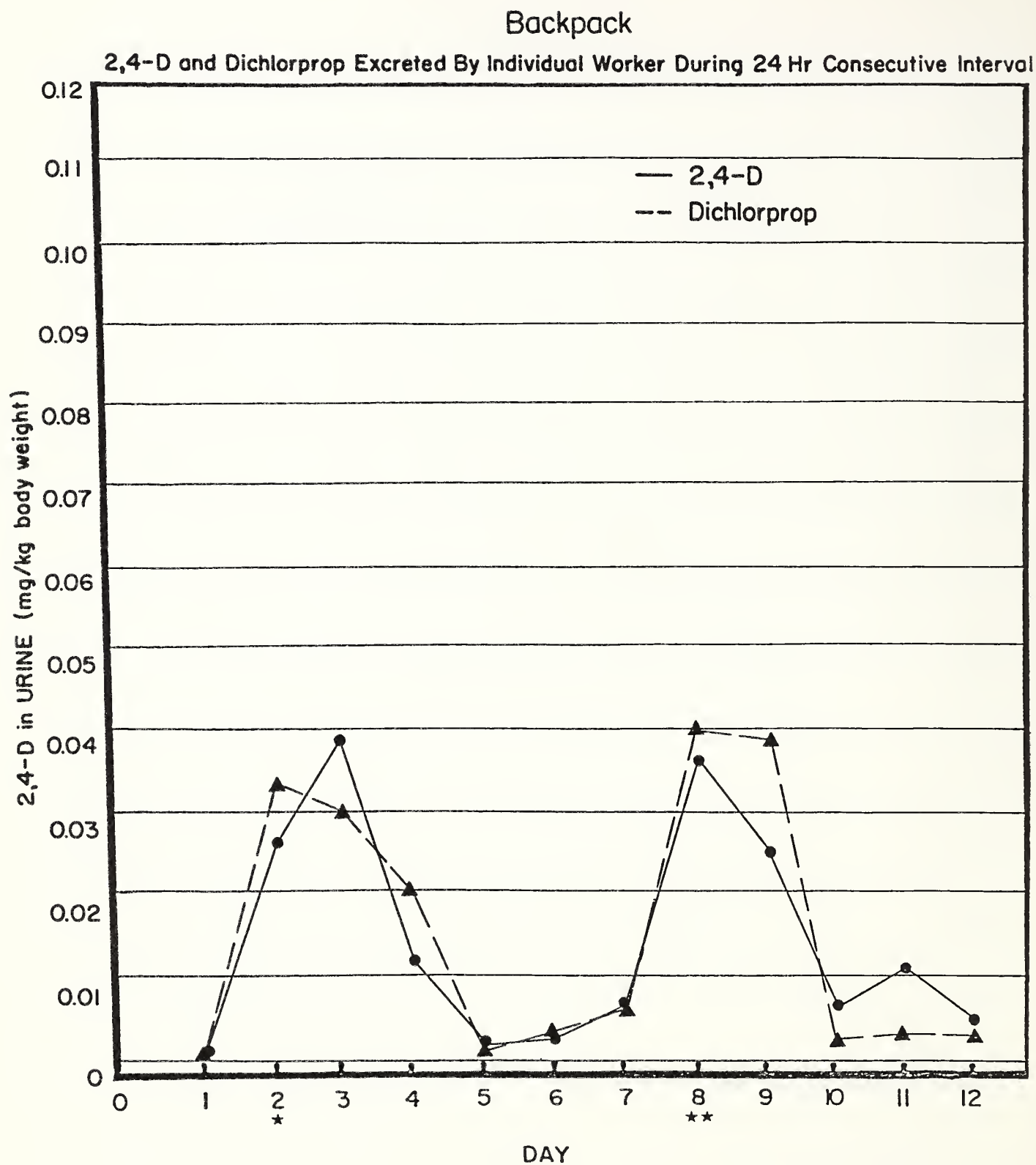
## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



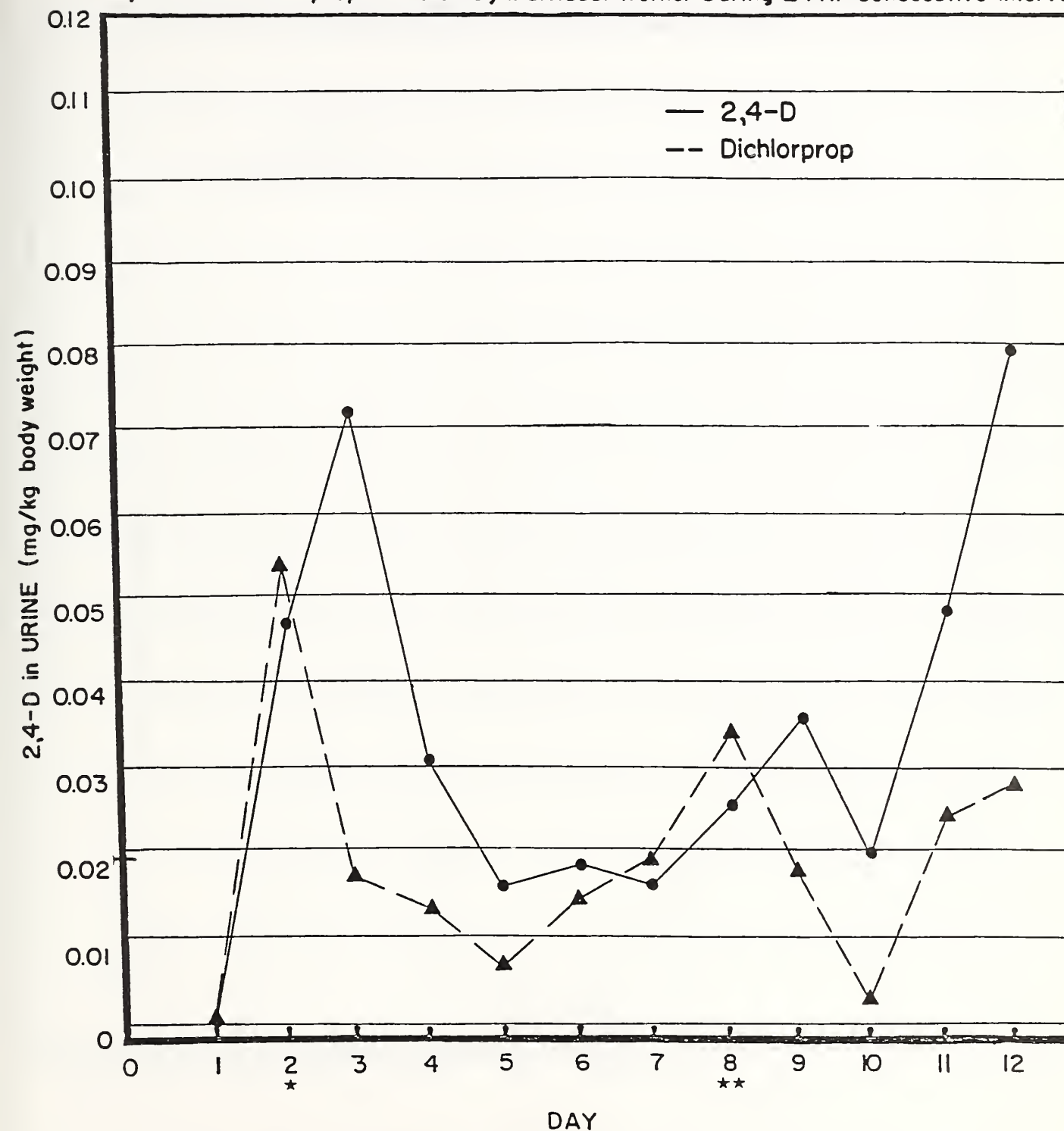
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



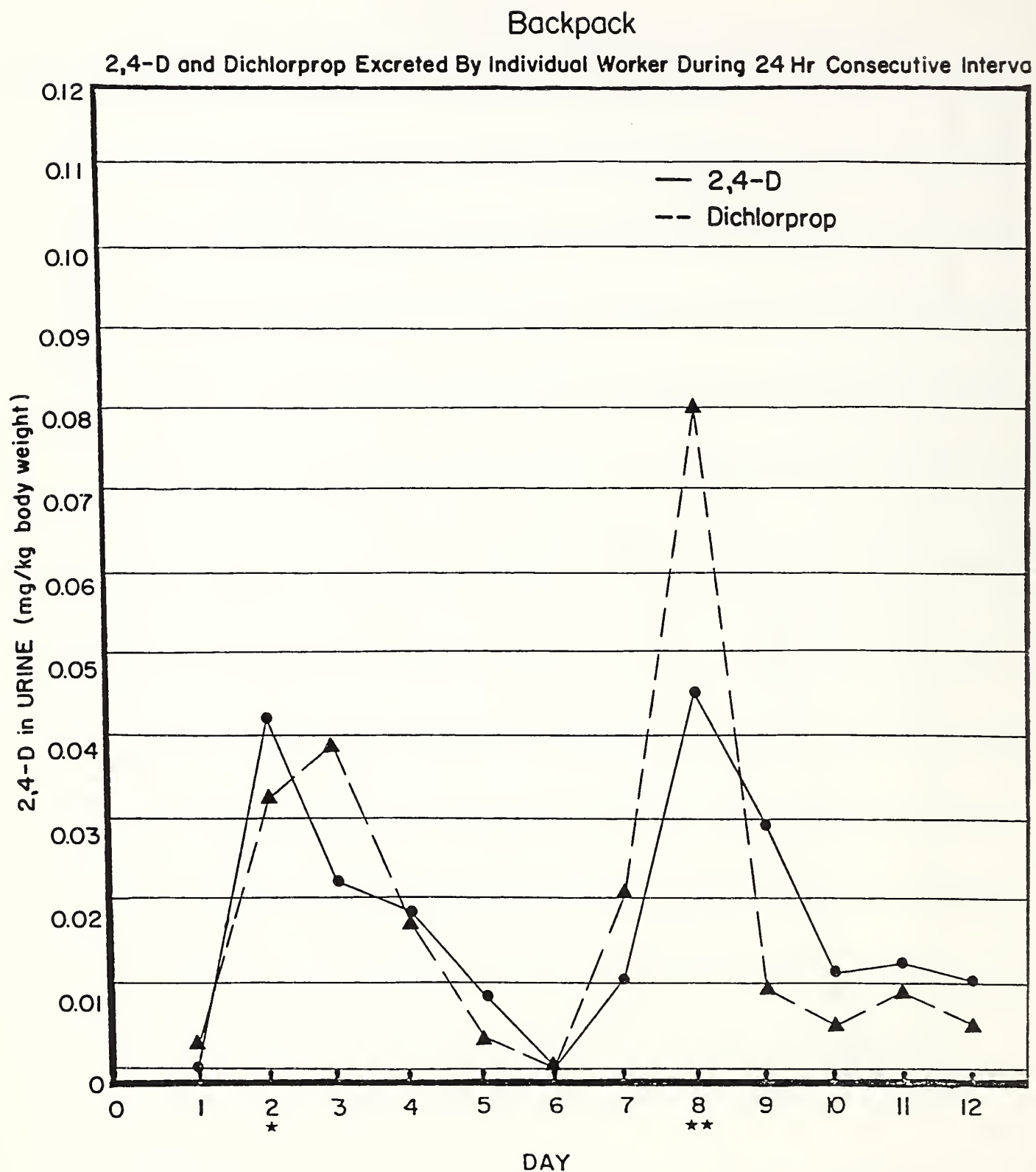
## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals



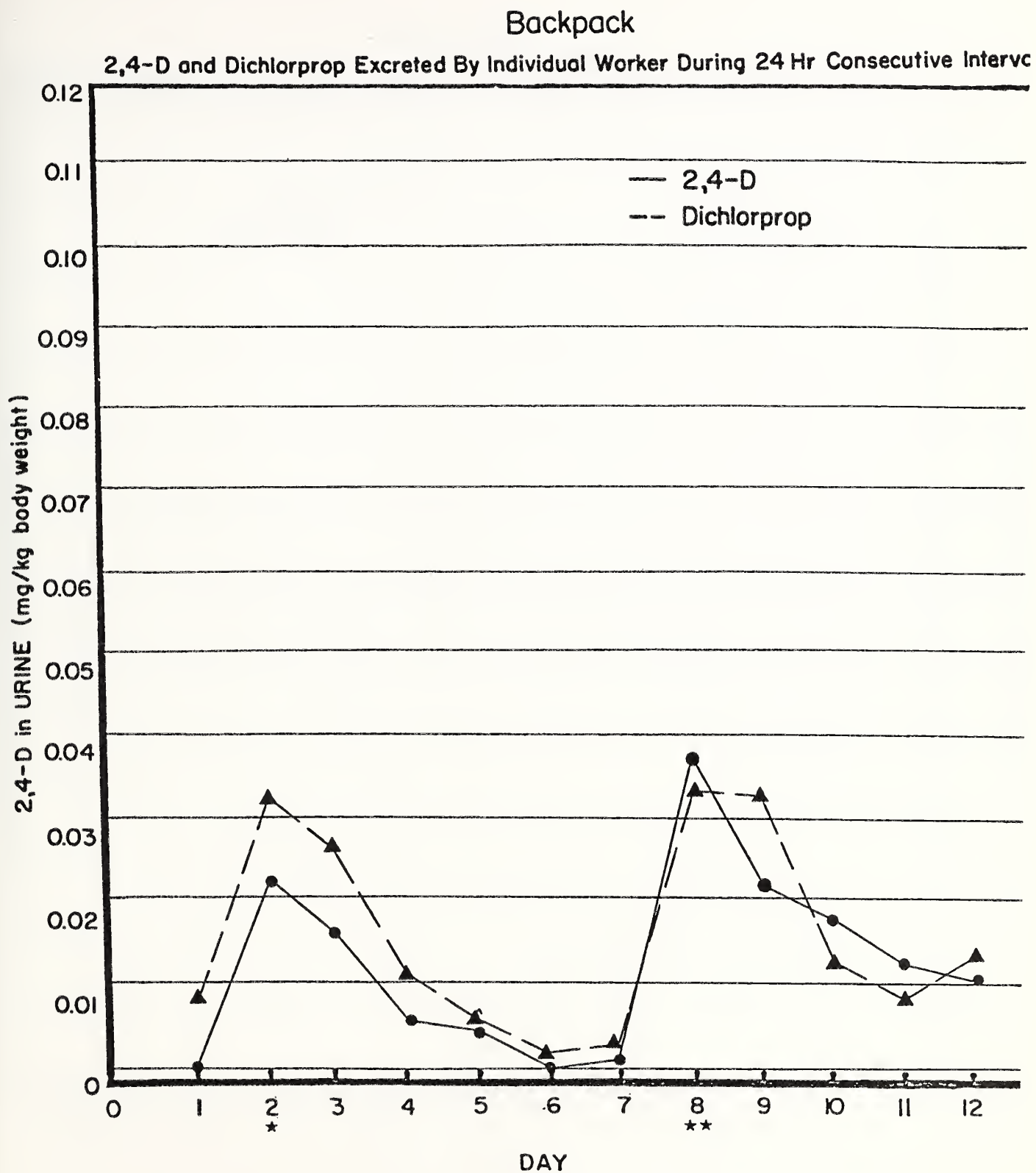
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



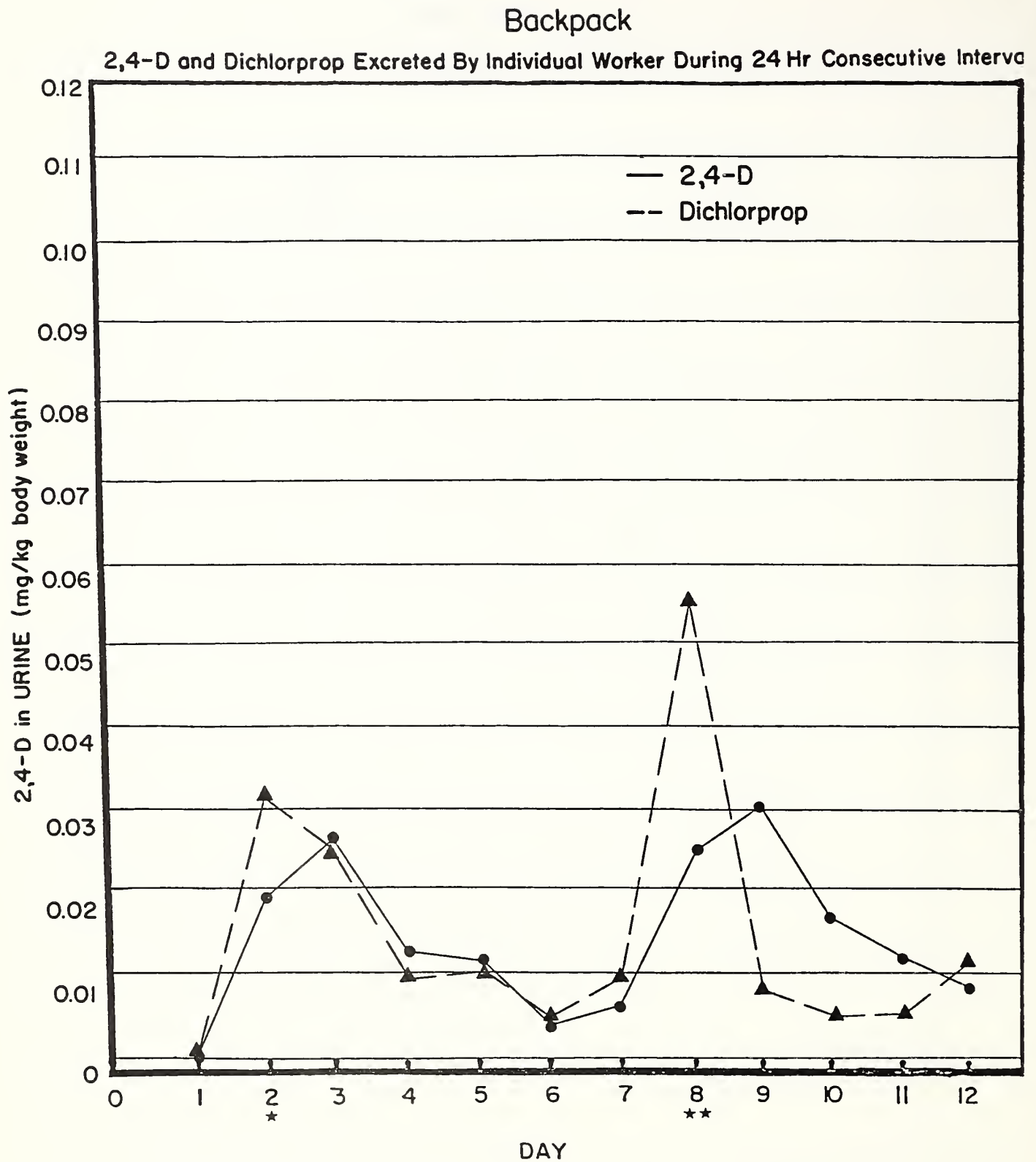
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



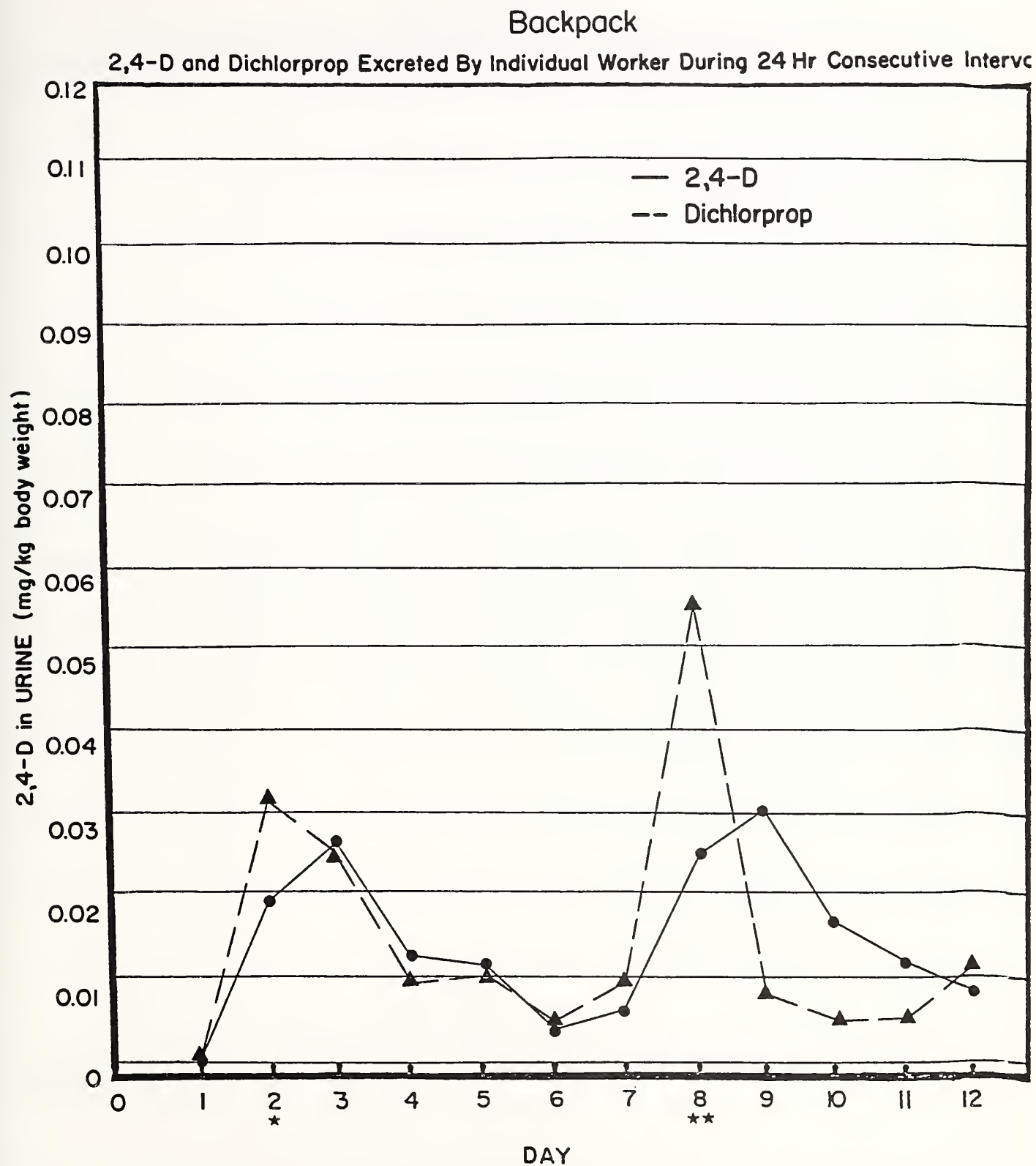
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

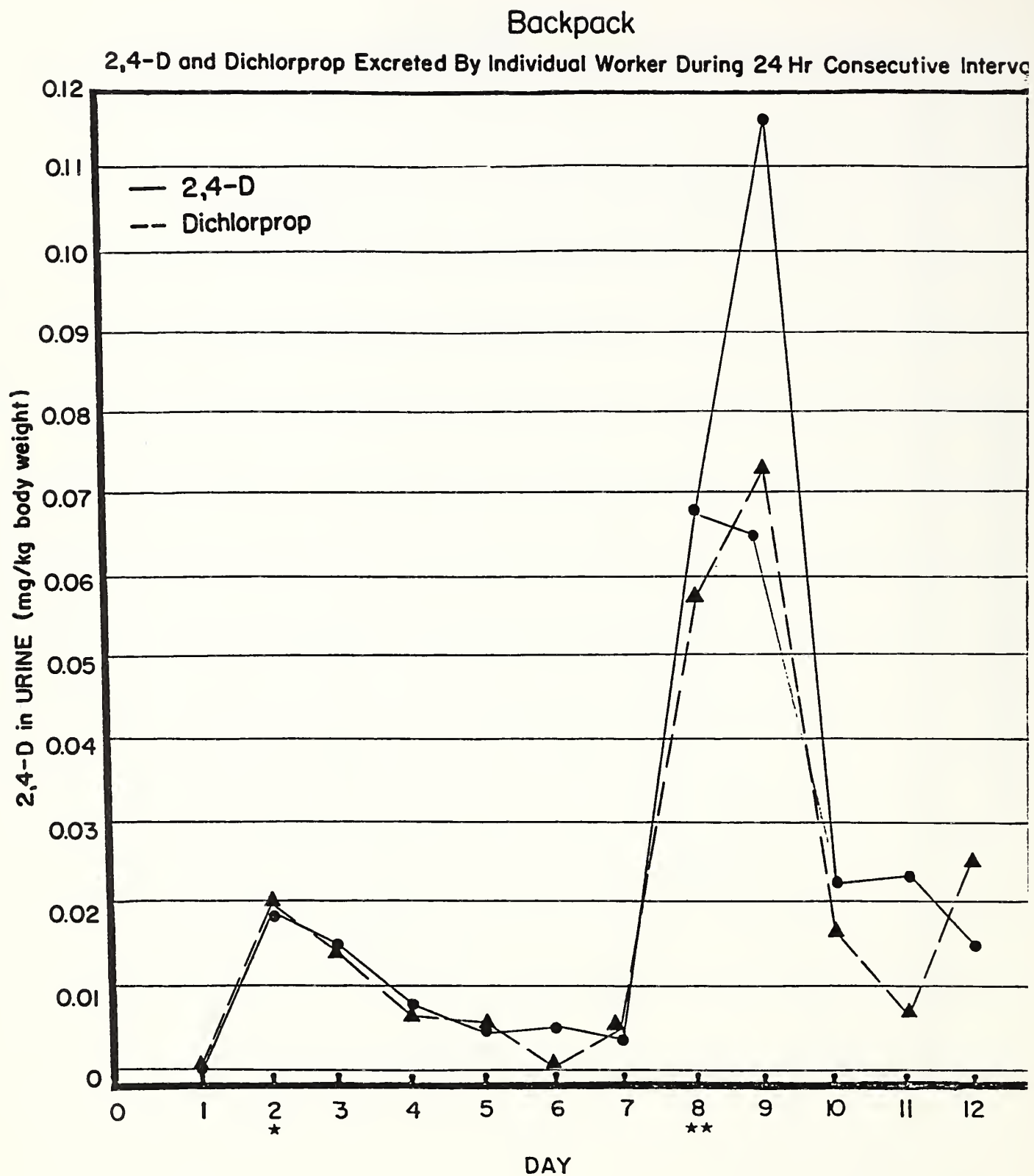
\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

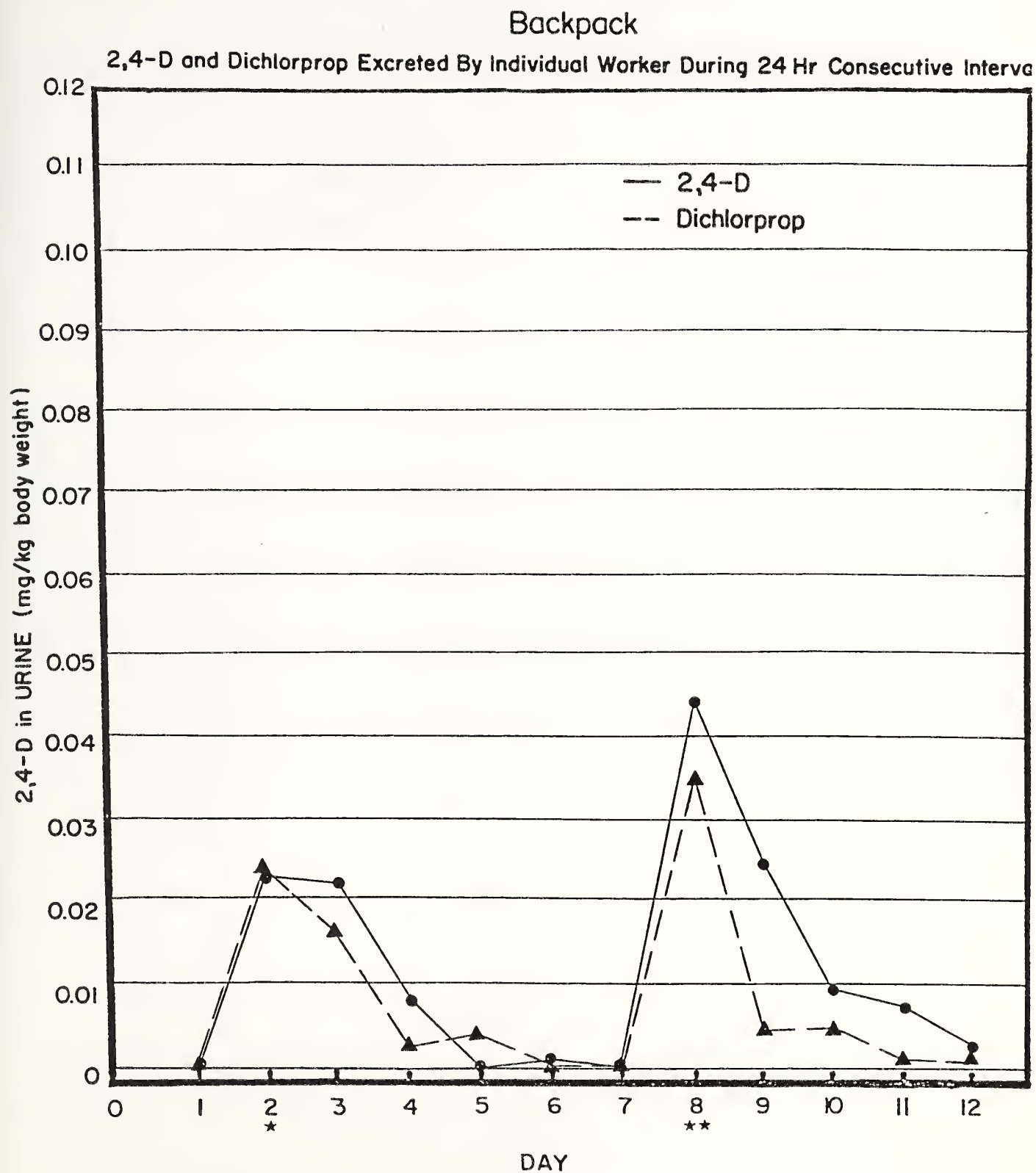
\*\* Treatment 2 - Special precautions observed





\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

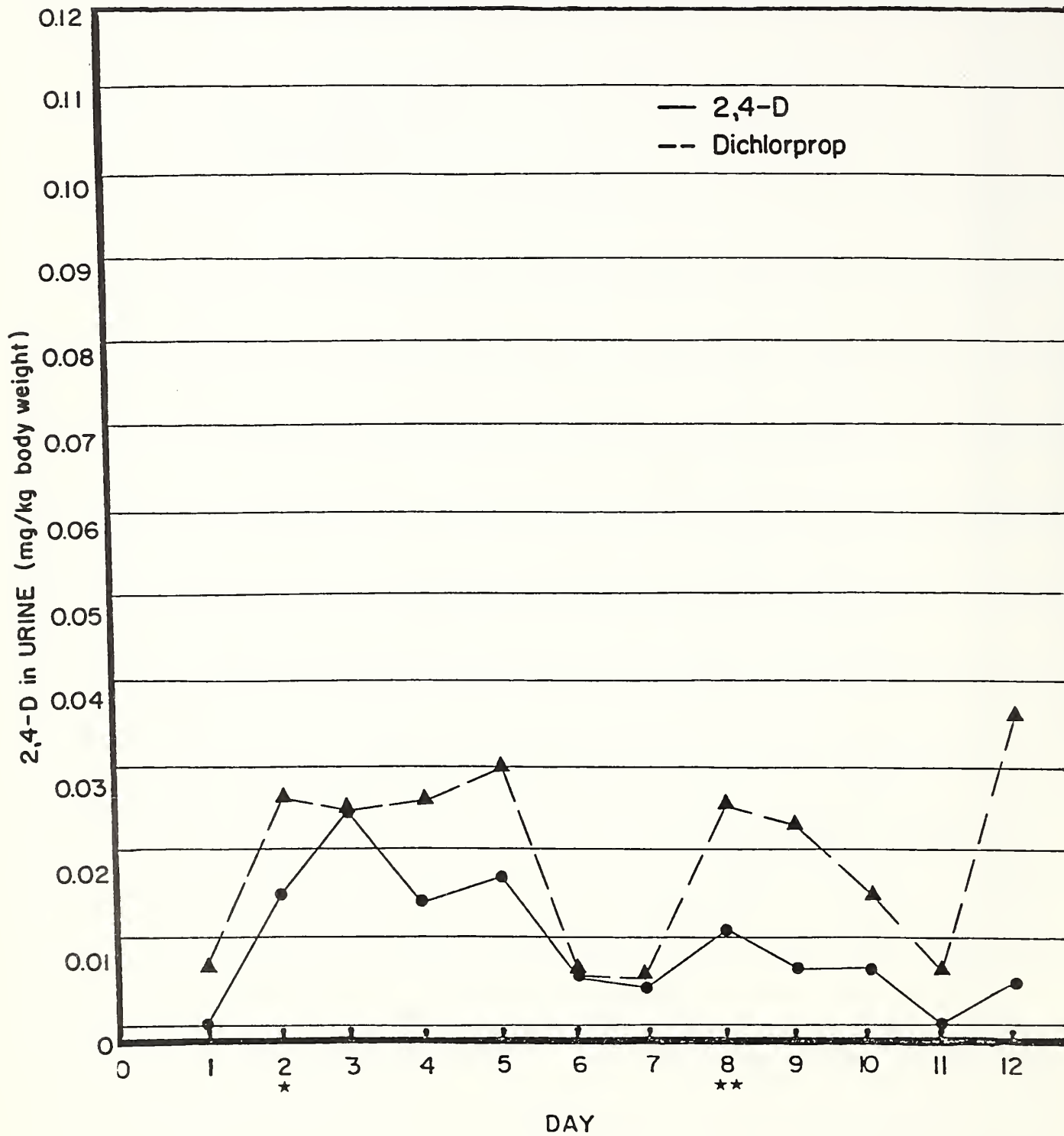


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

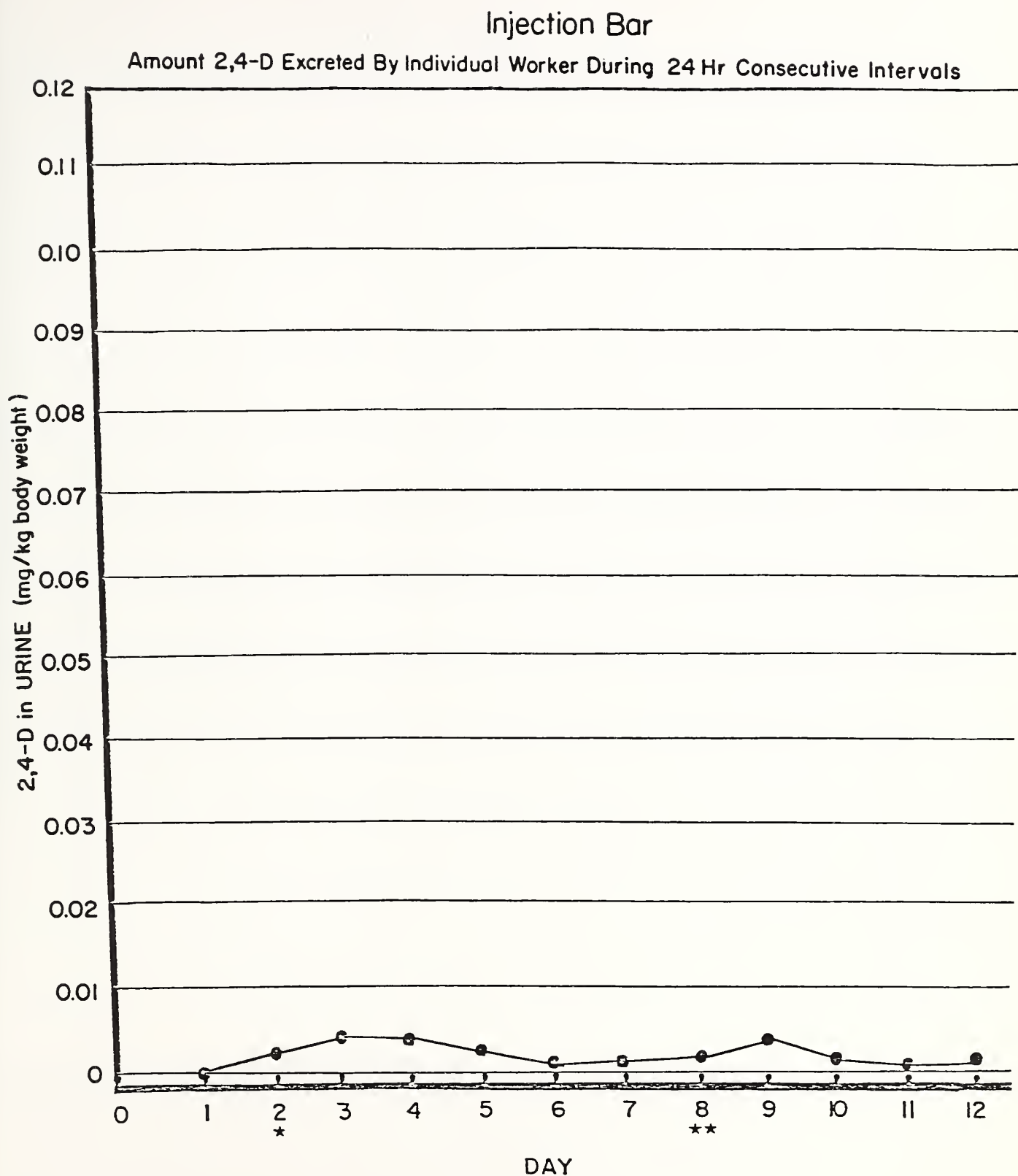
## Backpack

2,4-D and Dichlorprop Excreted By Individual Worker During 24 Hr Consecutive Intervals



★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

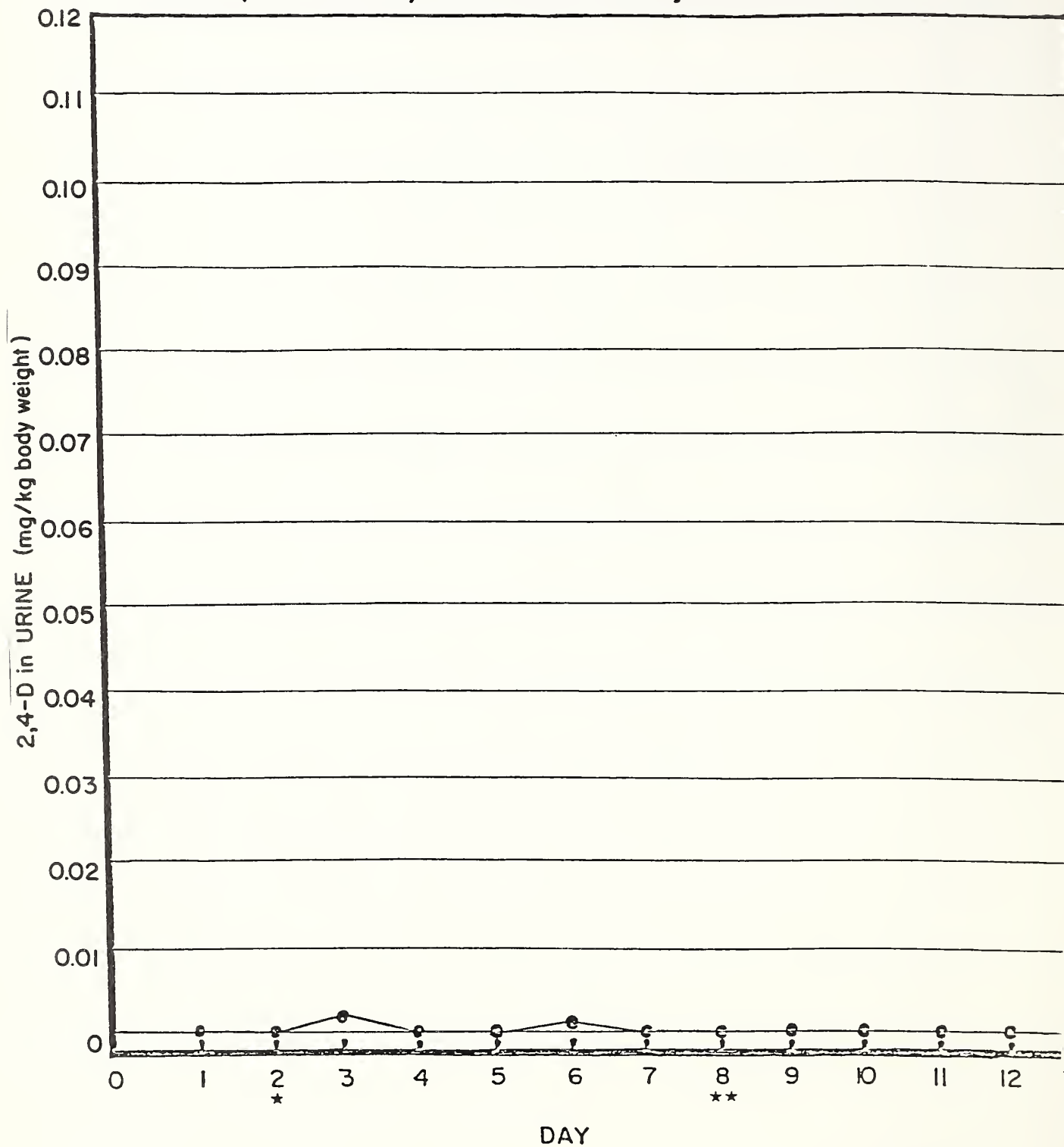


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



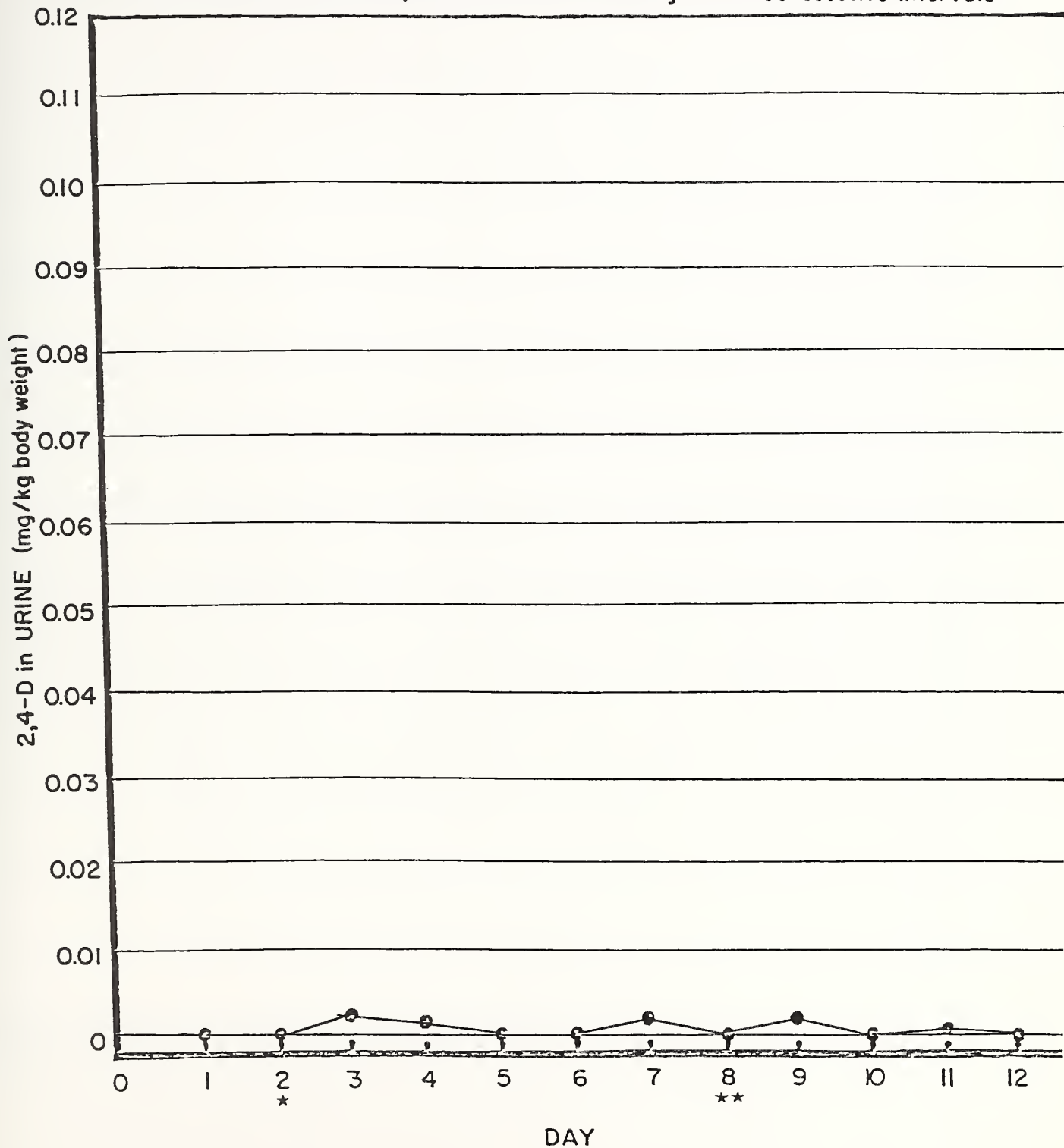
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

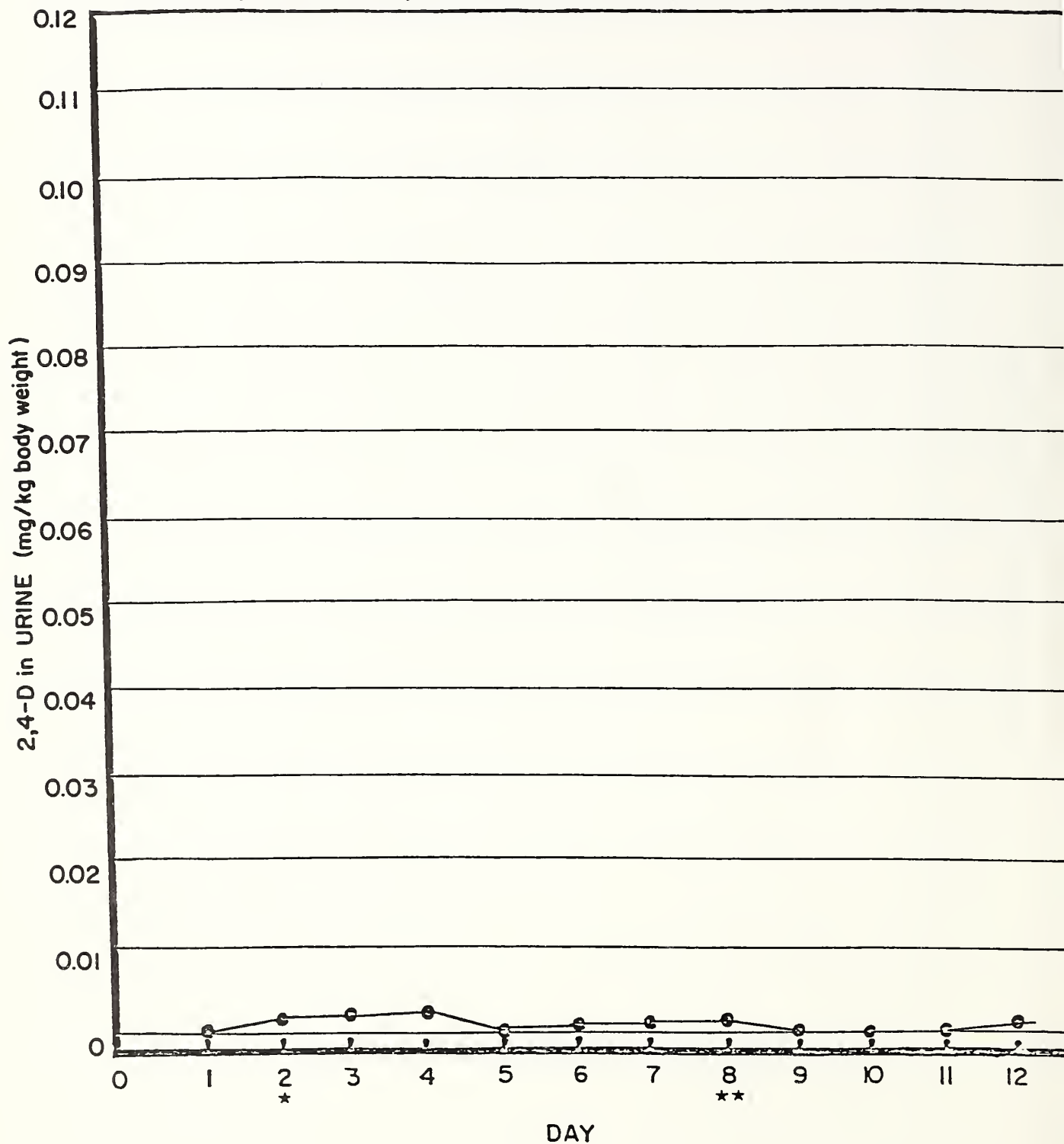


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

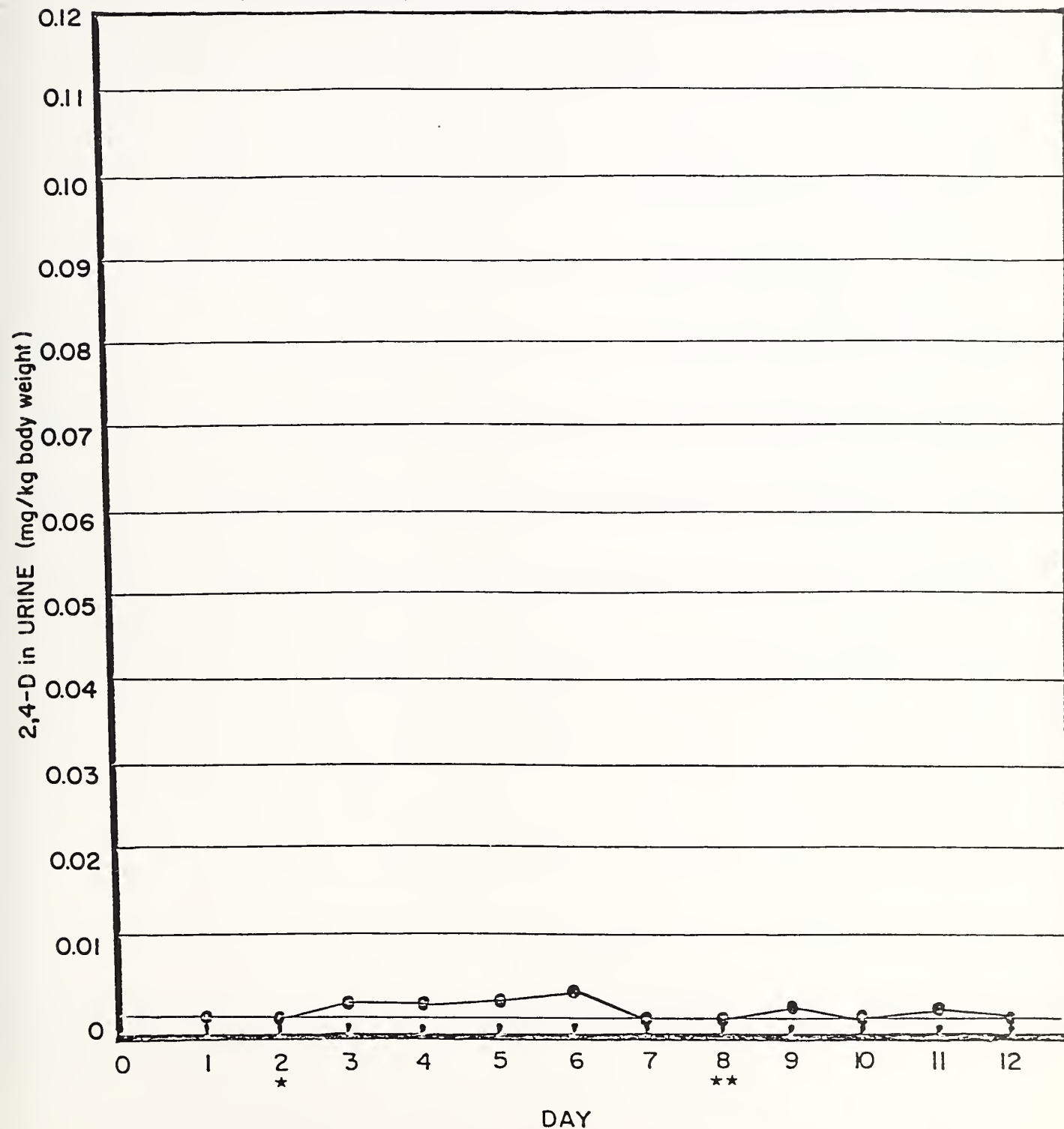


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

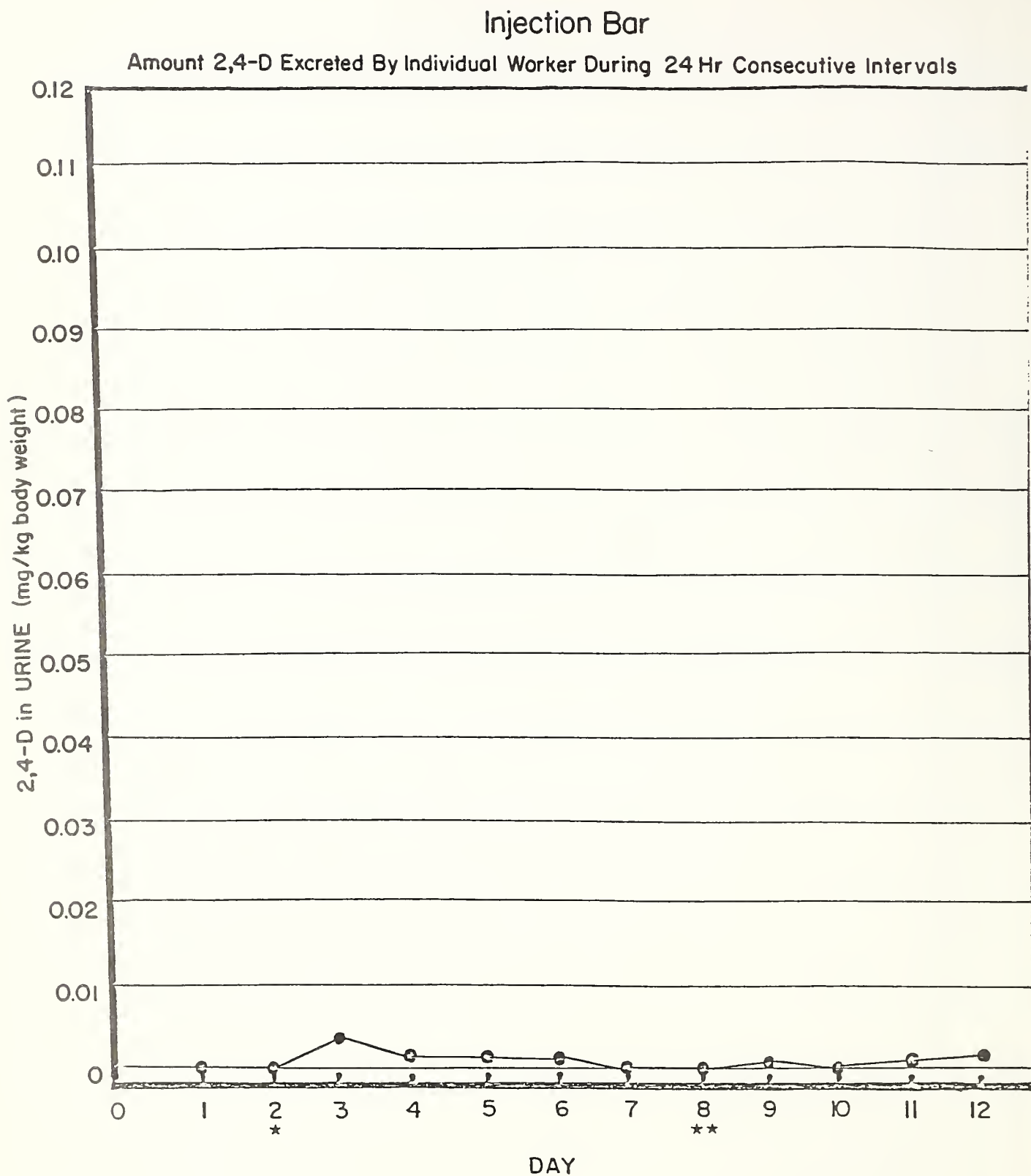
## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



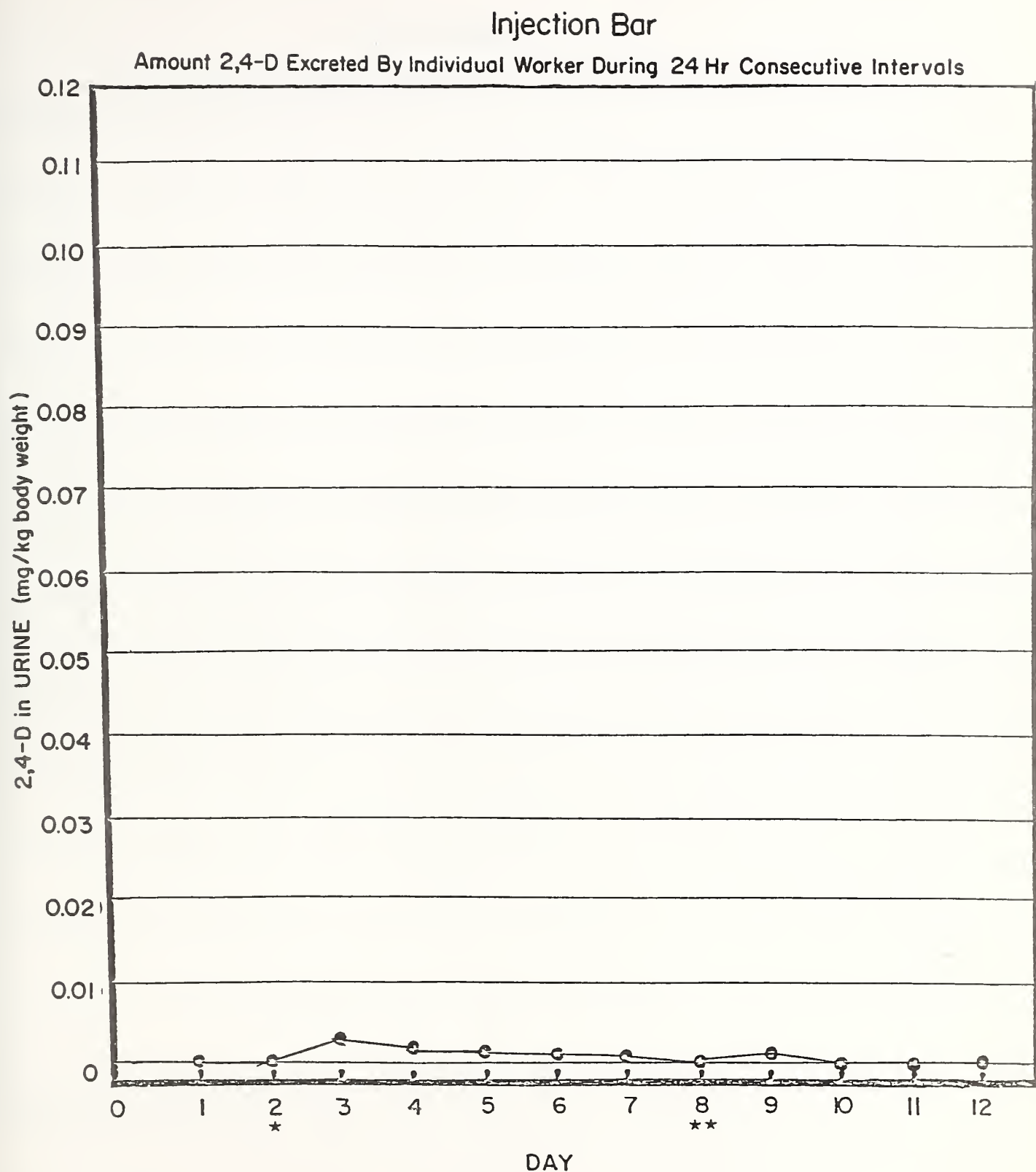
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

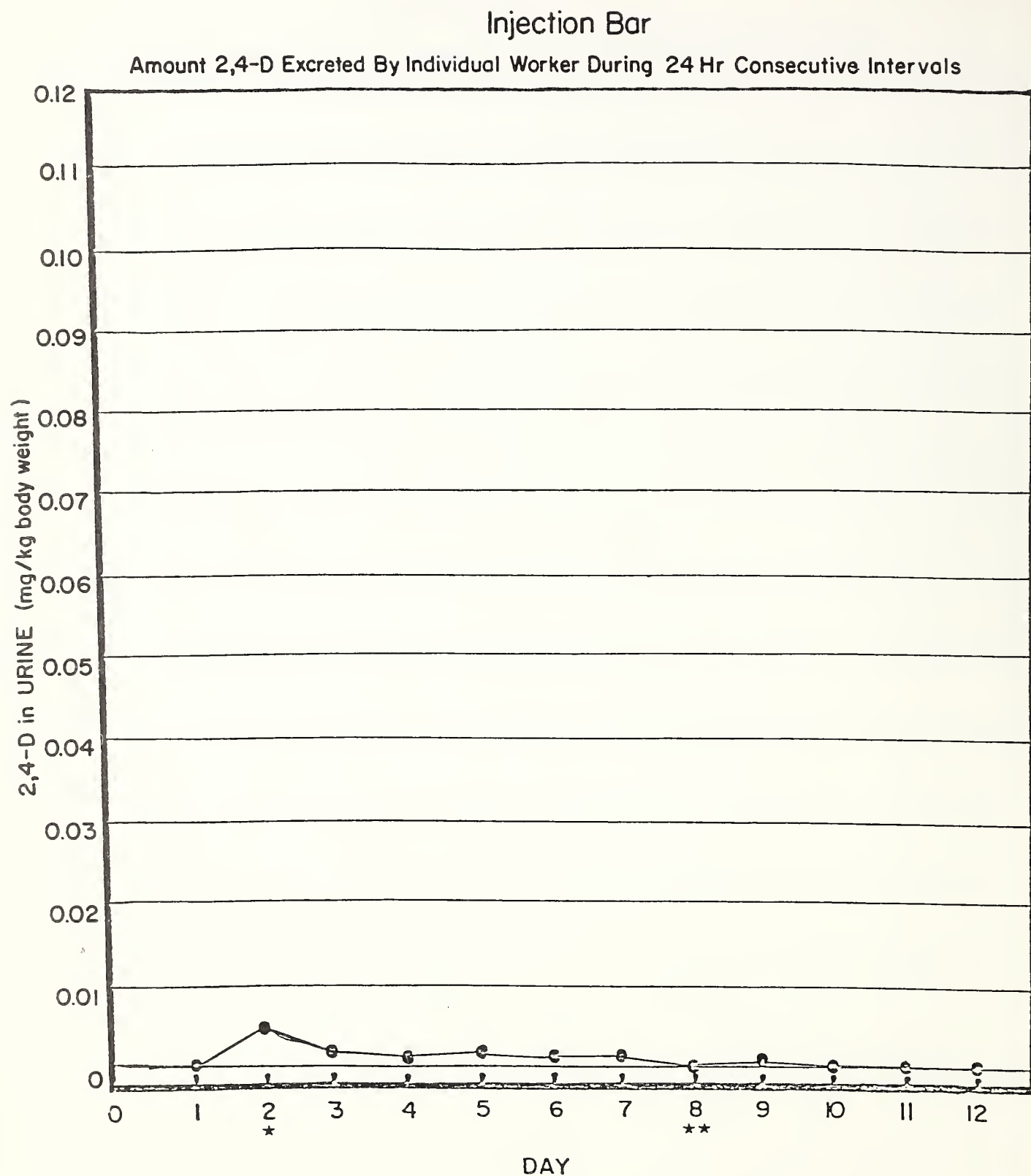
\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



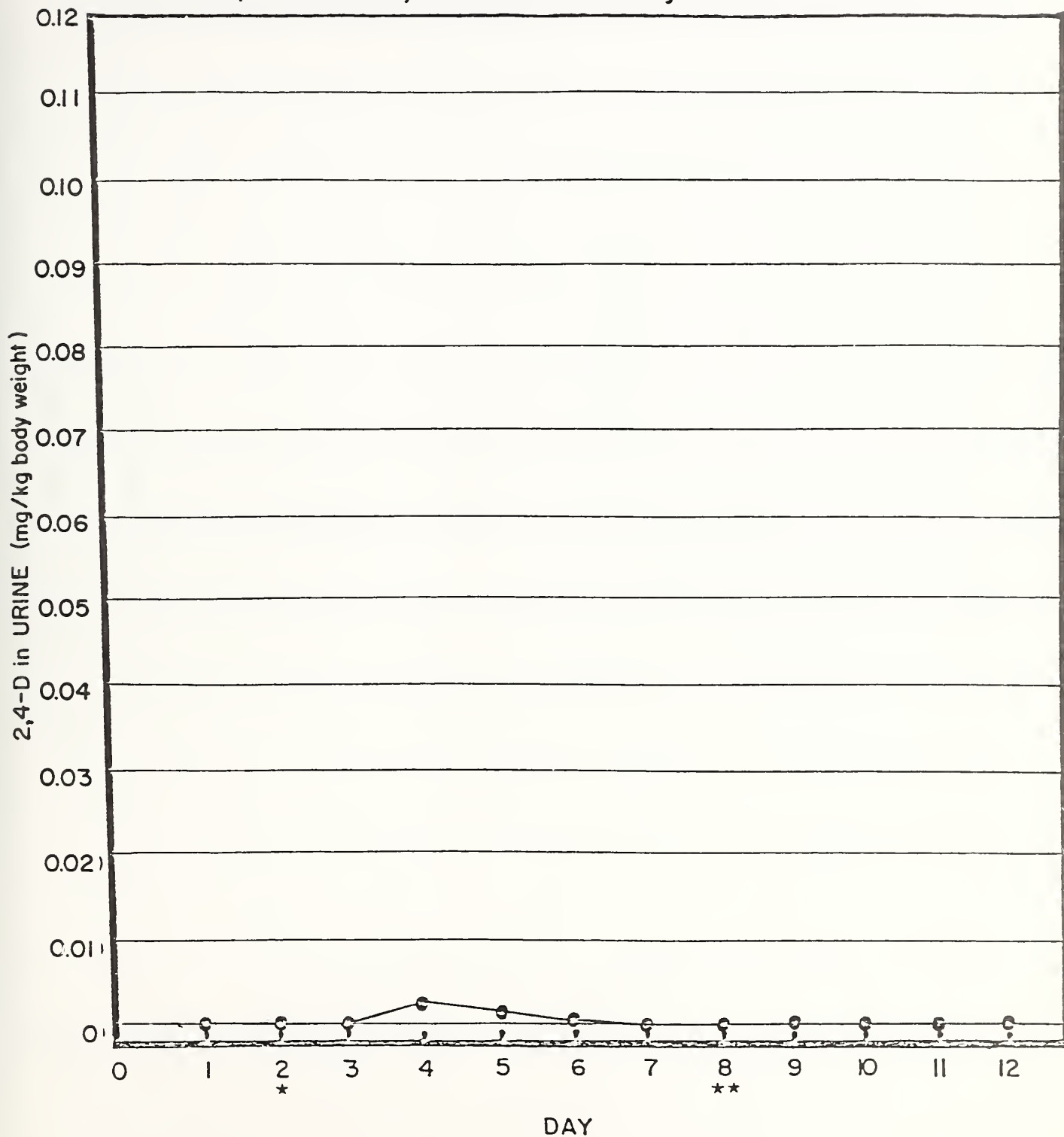


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

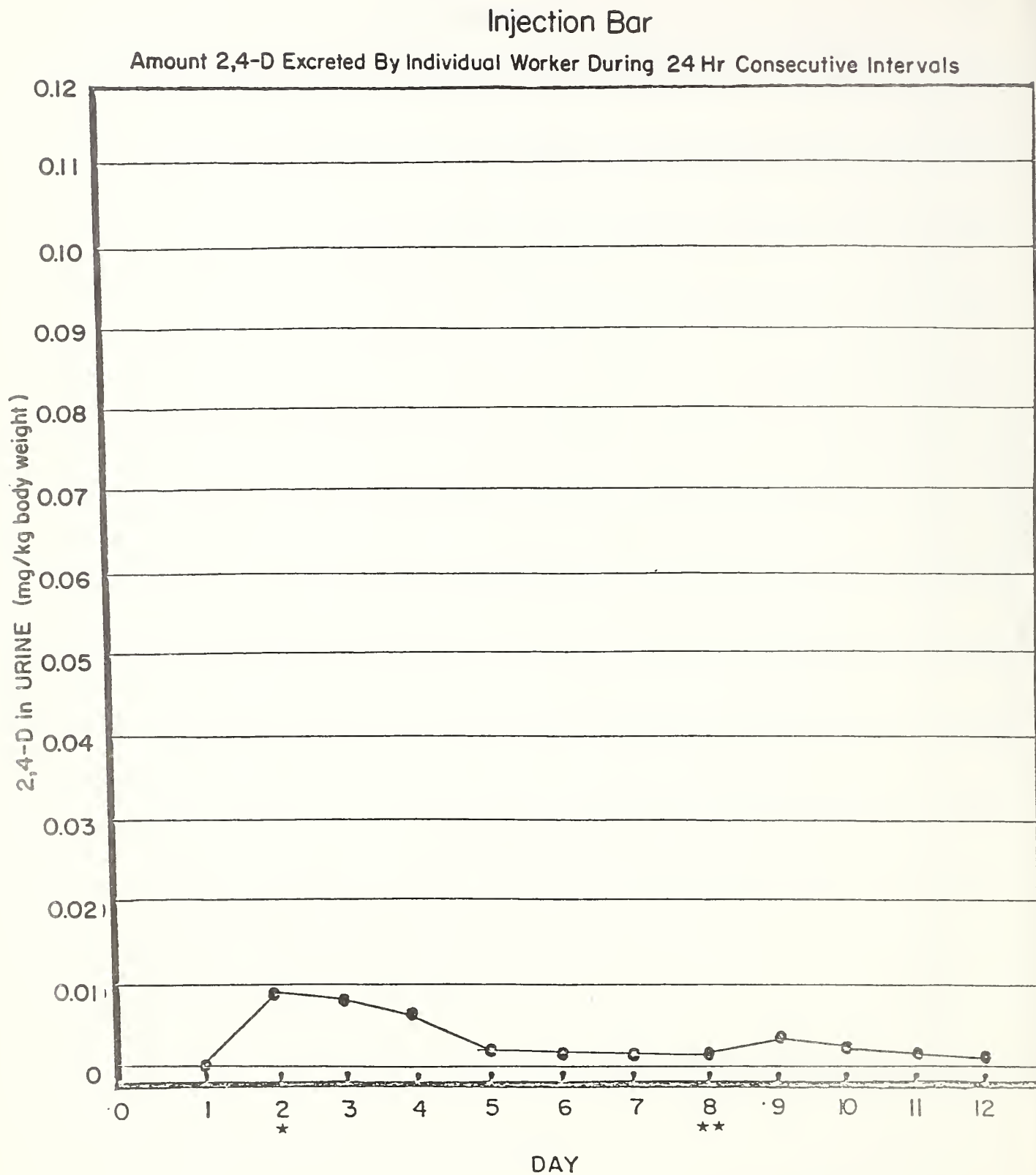
## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



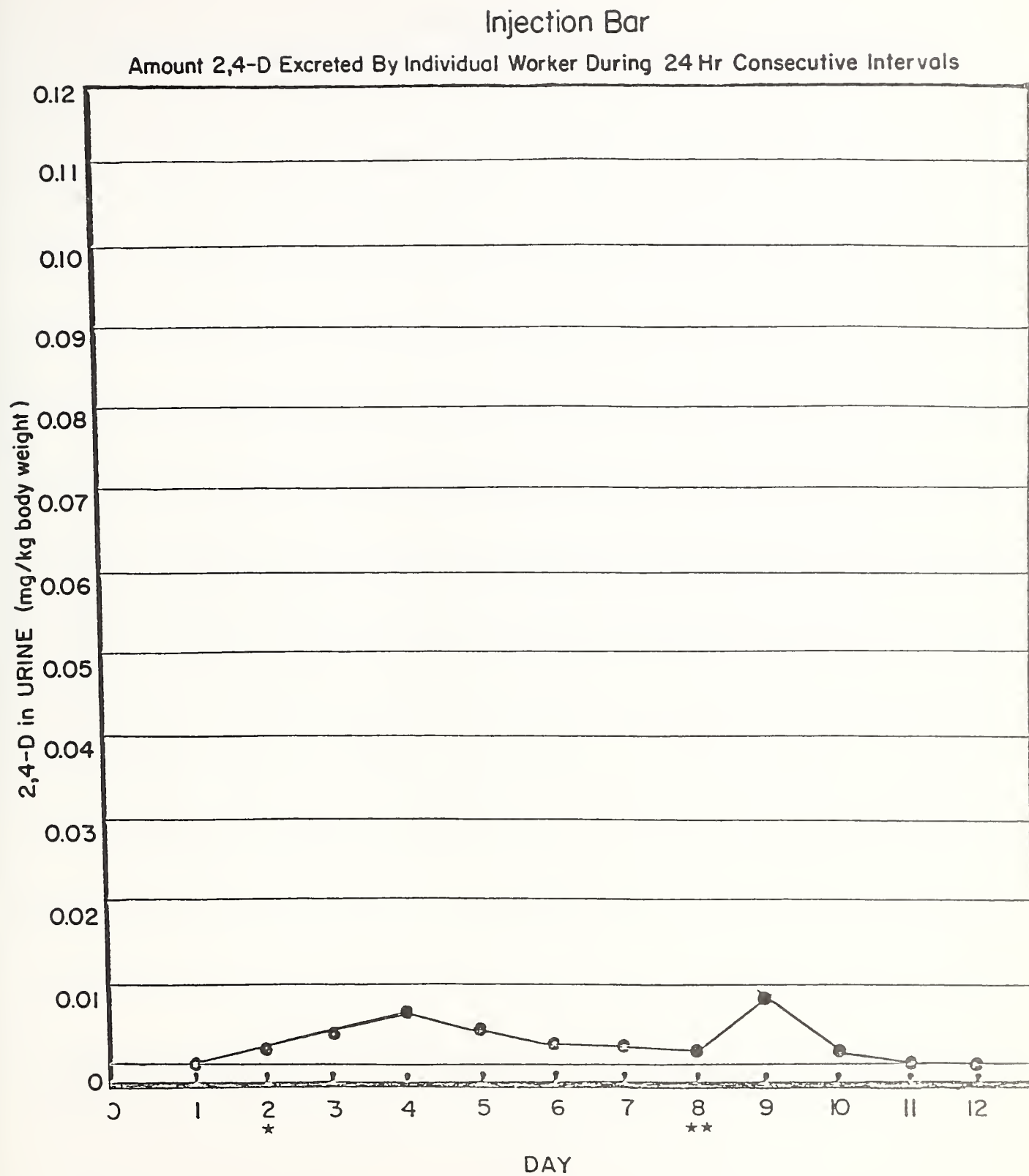
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

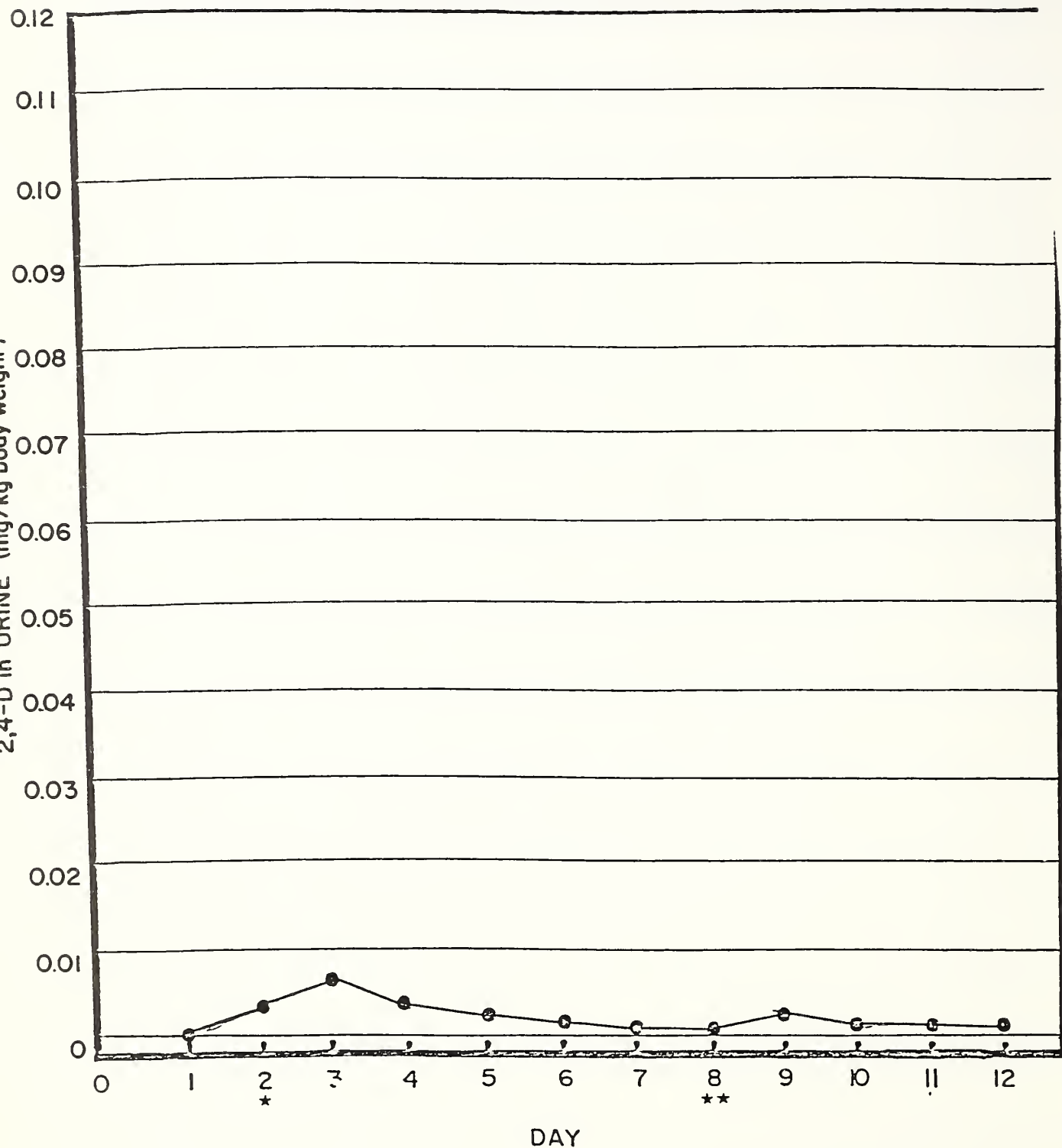


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



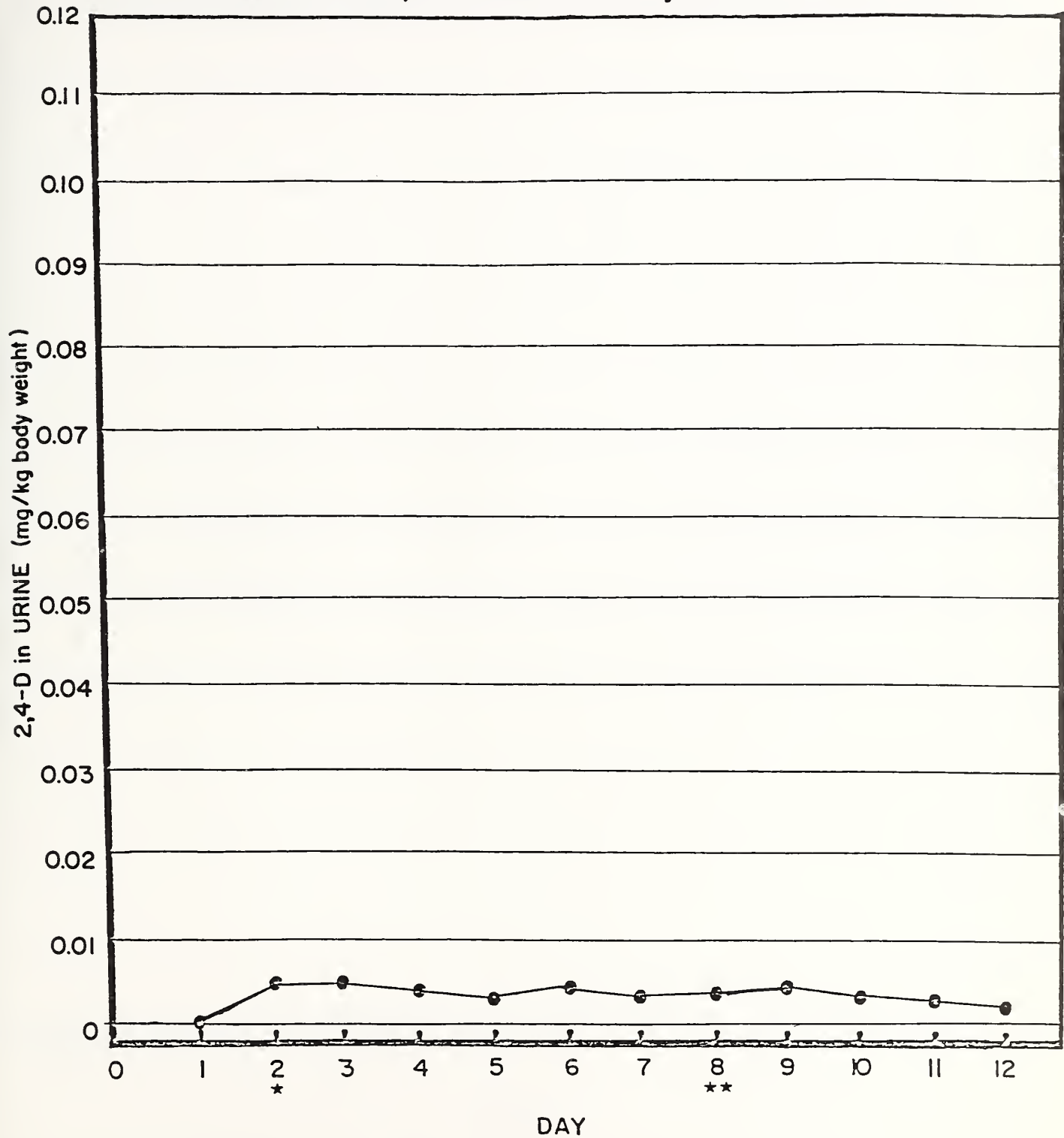
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

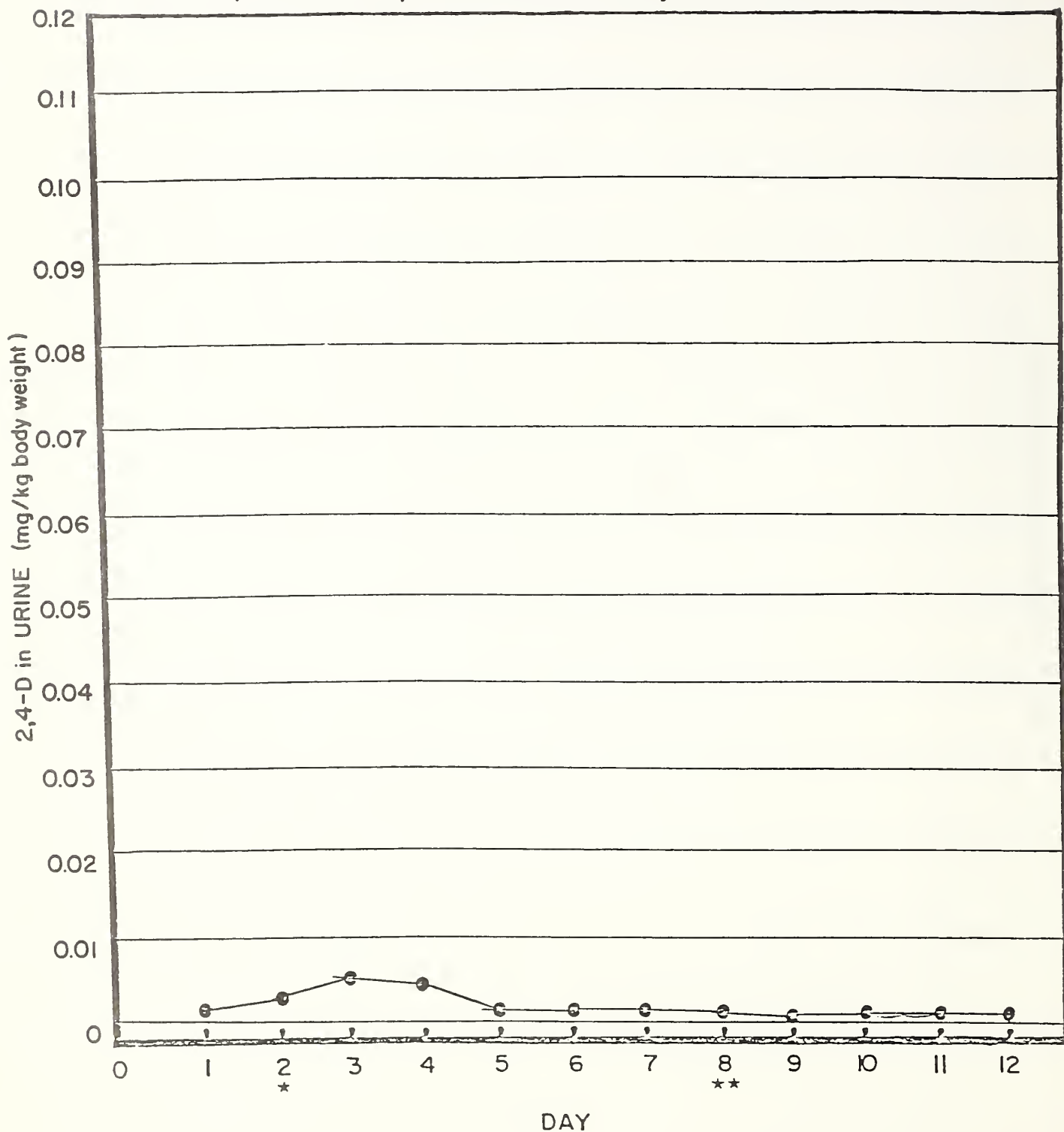


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

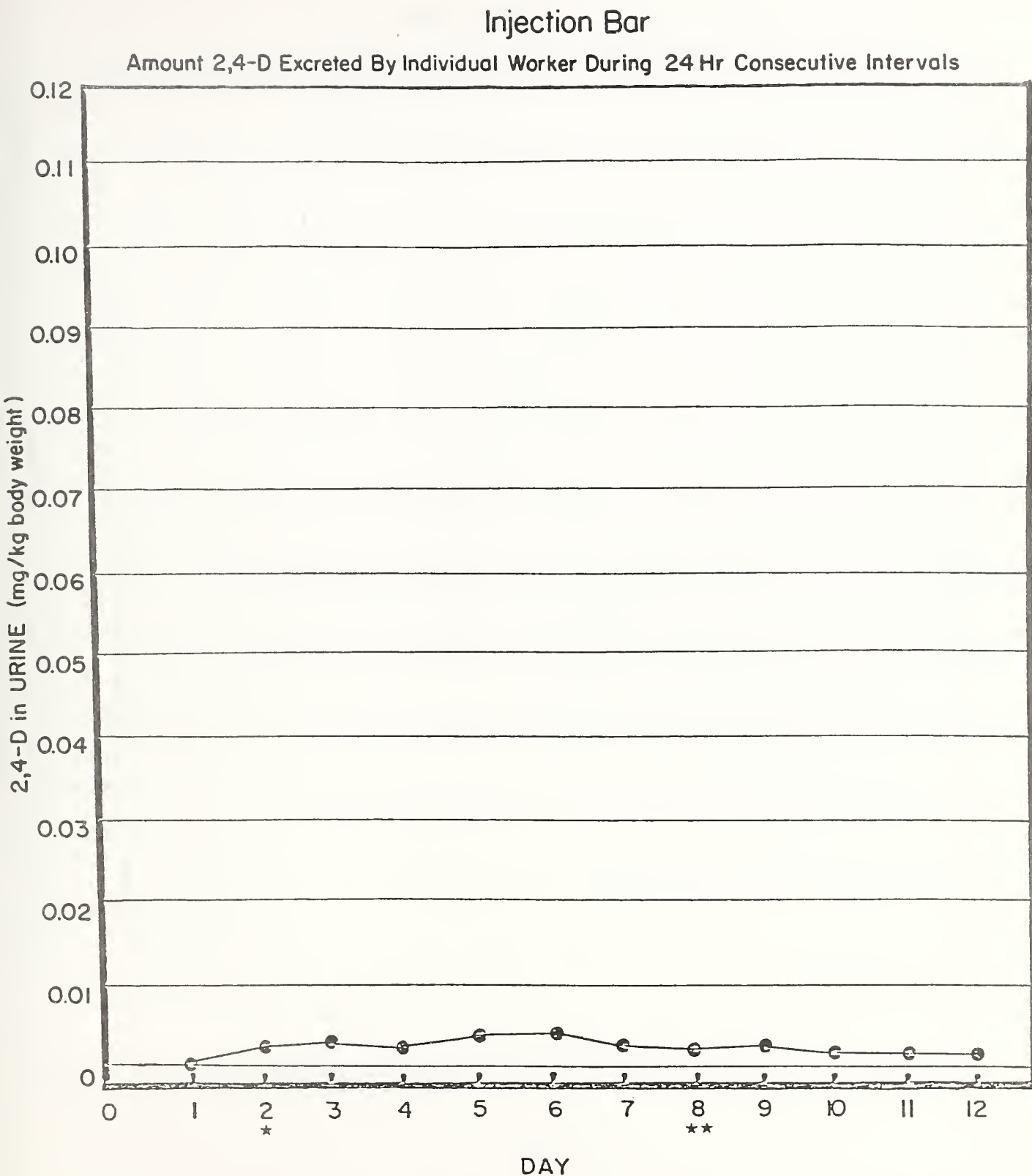
## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

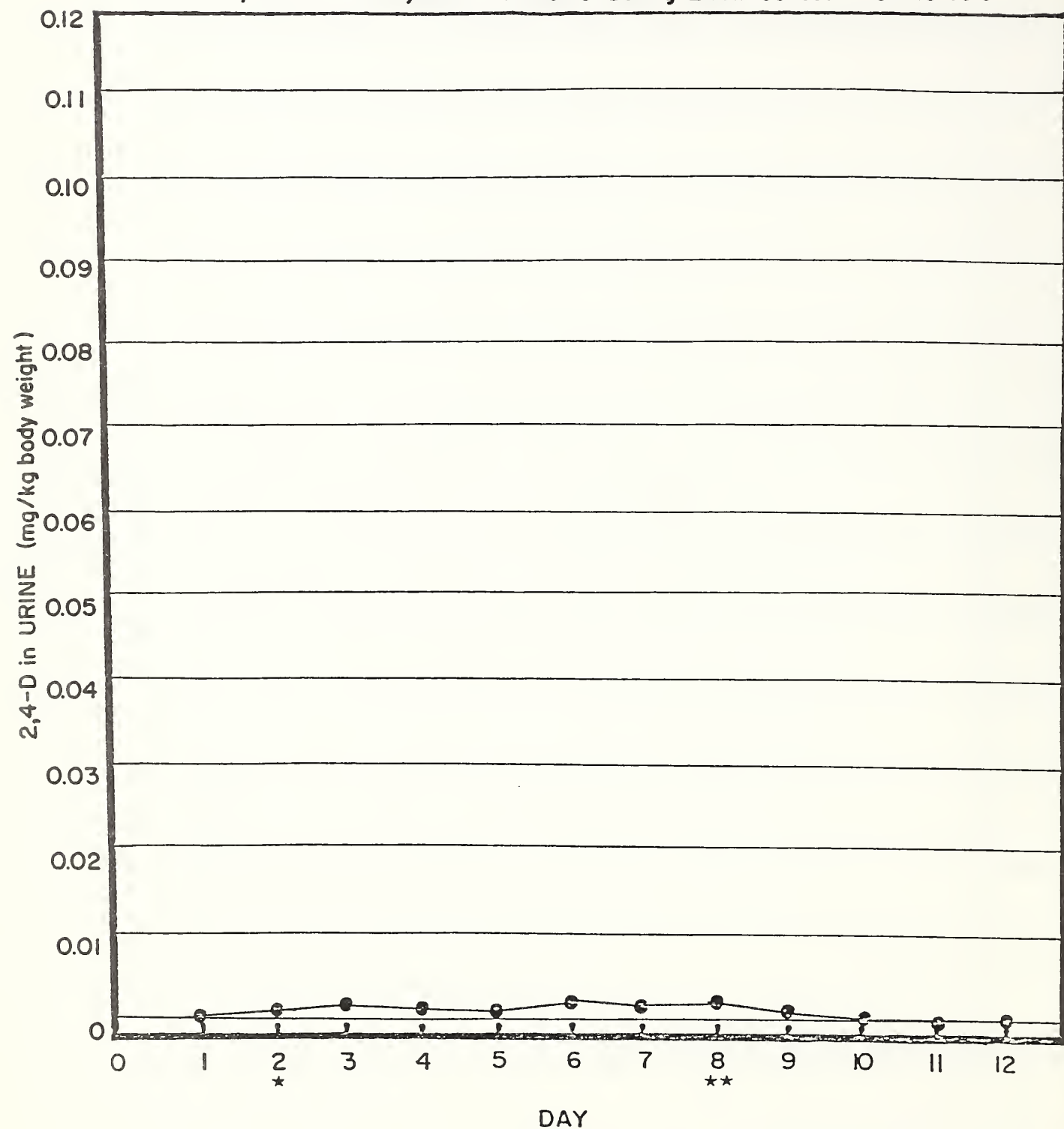


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

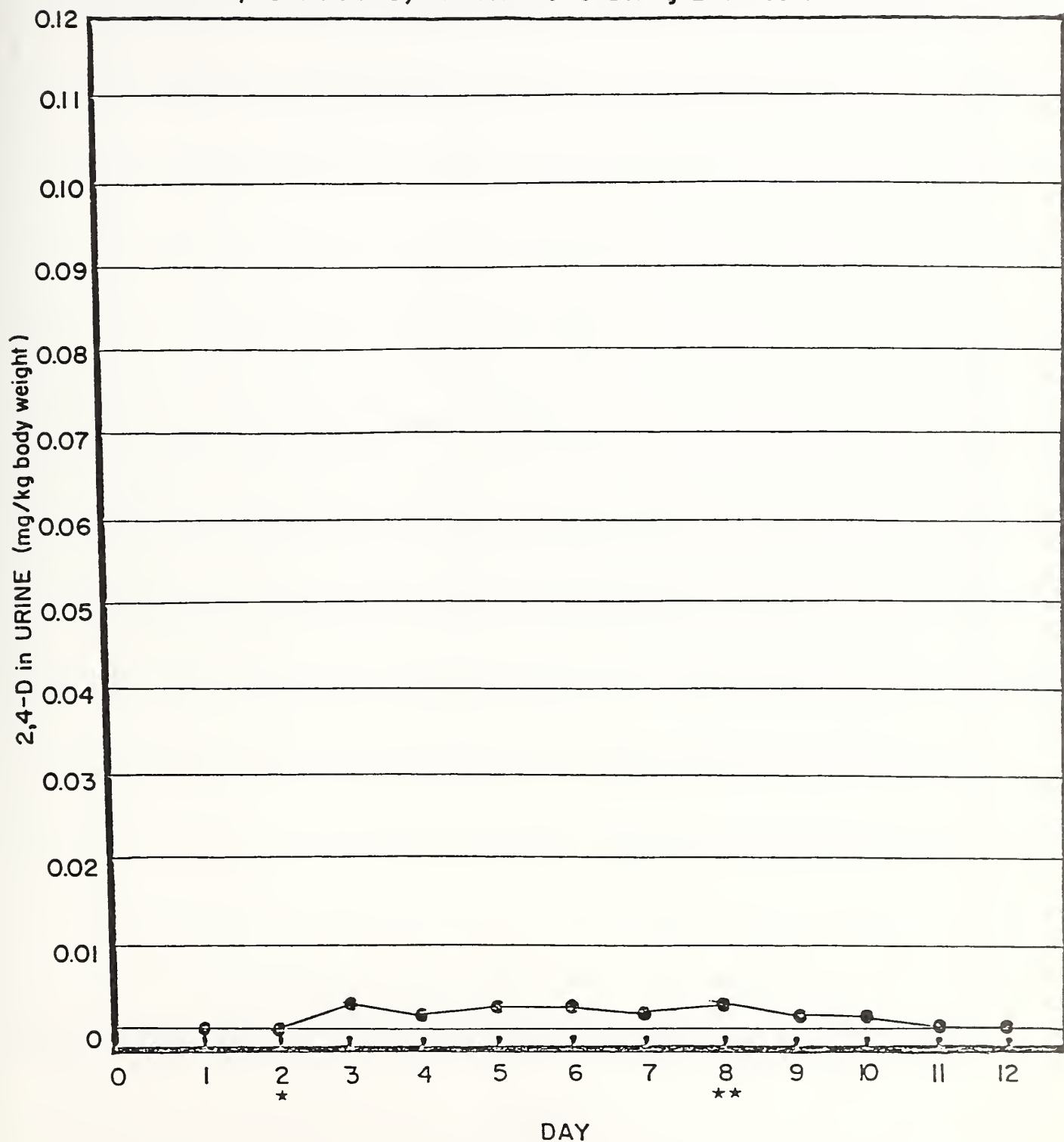


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



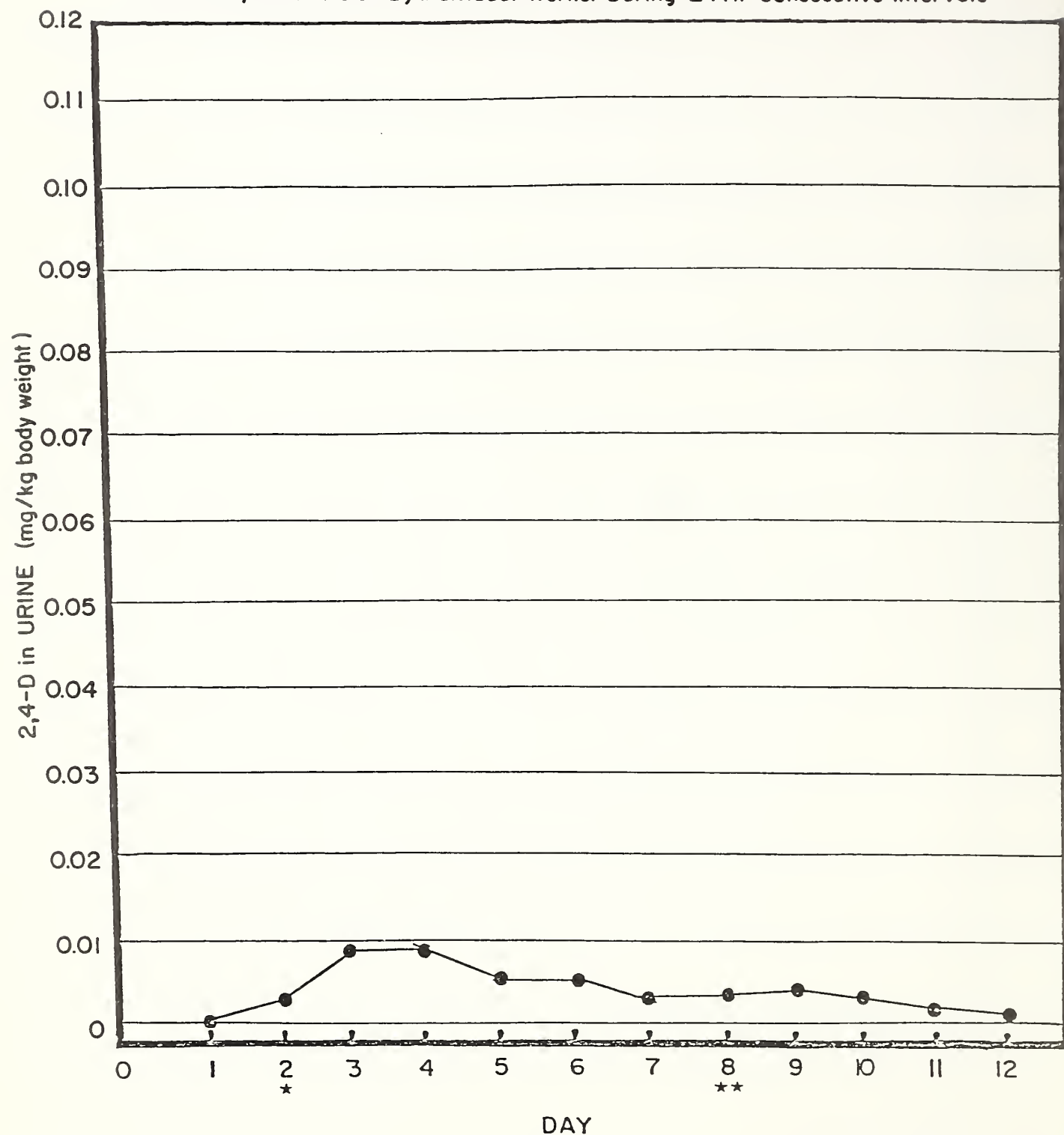
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



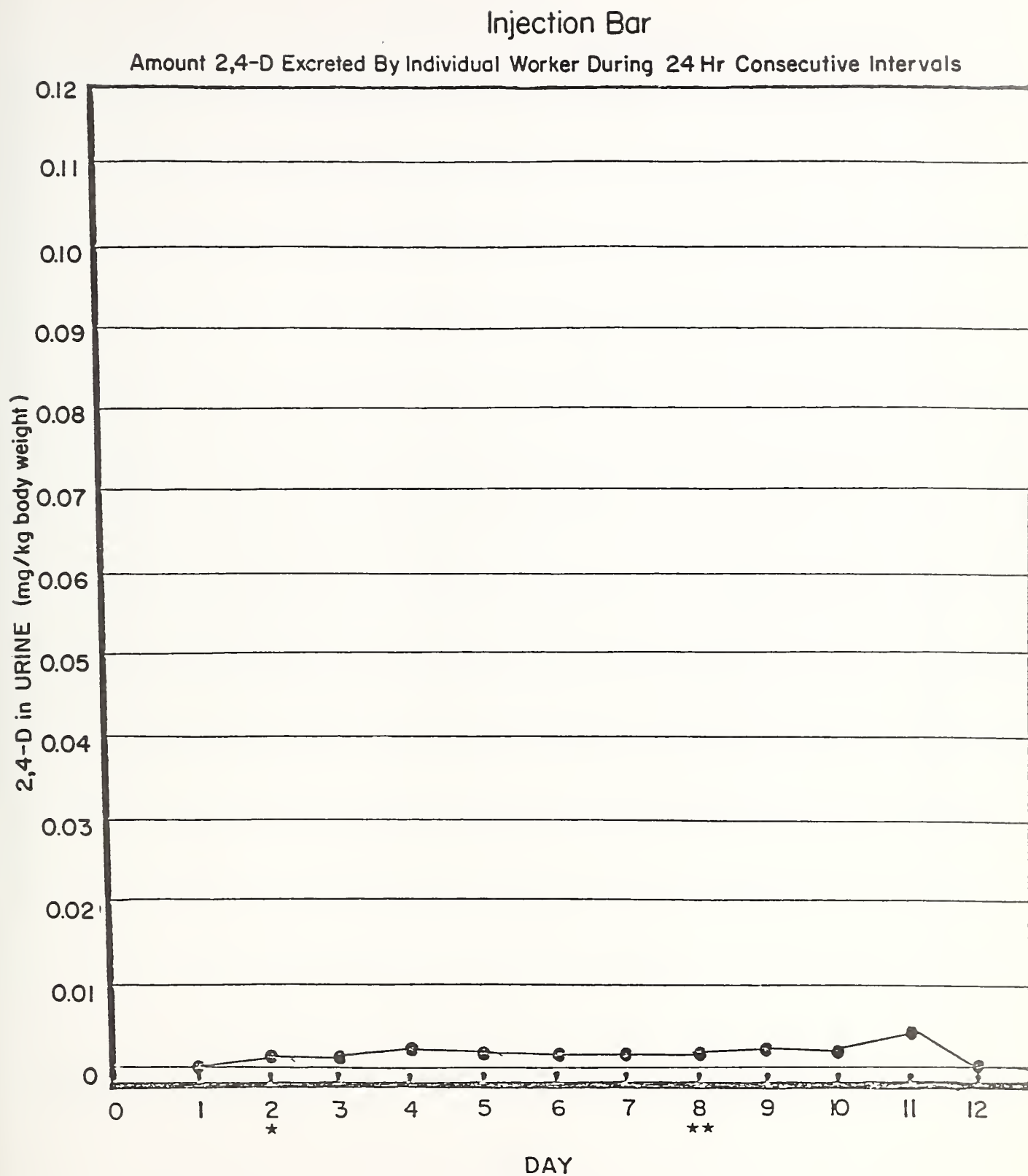
## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

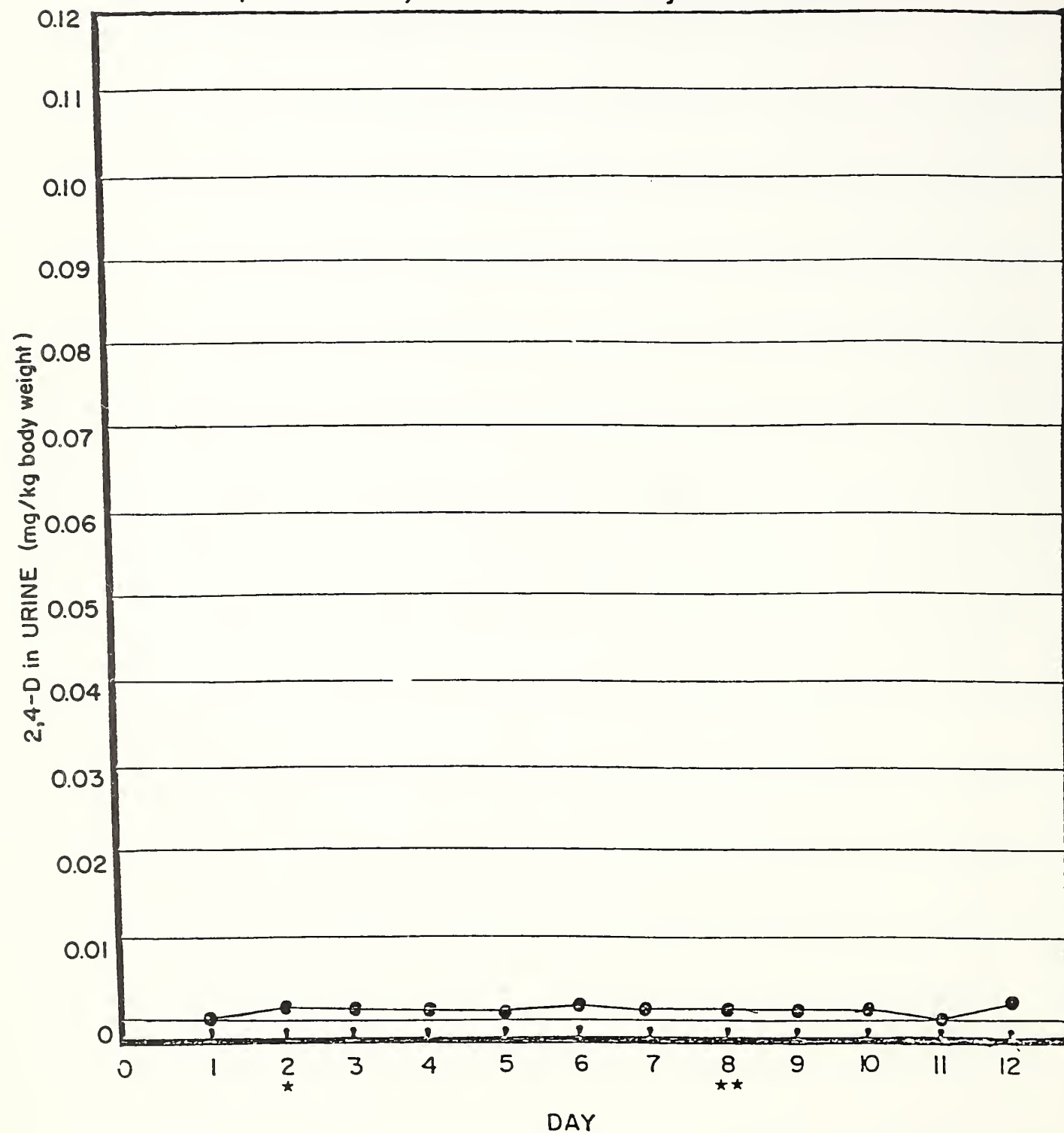


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Injection Bar

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

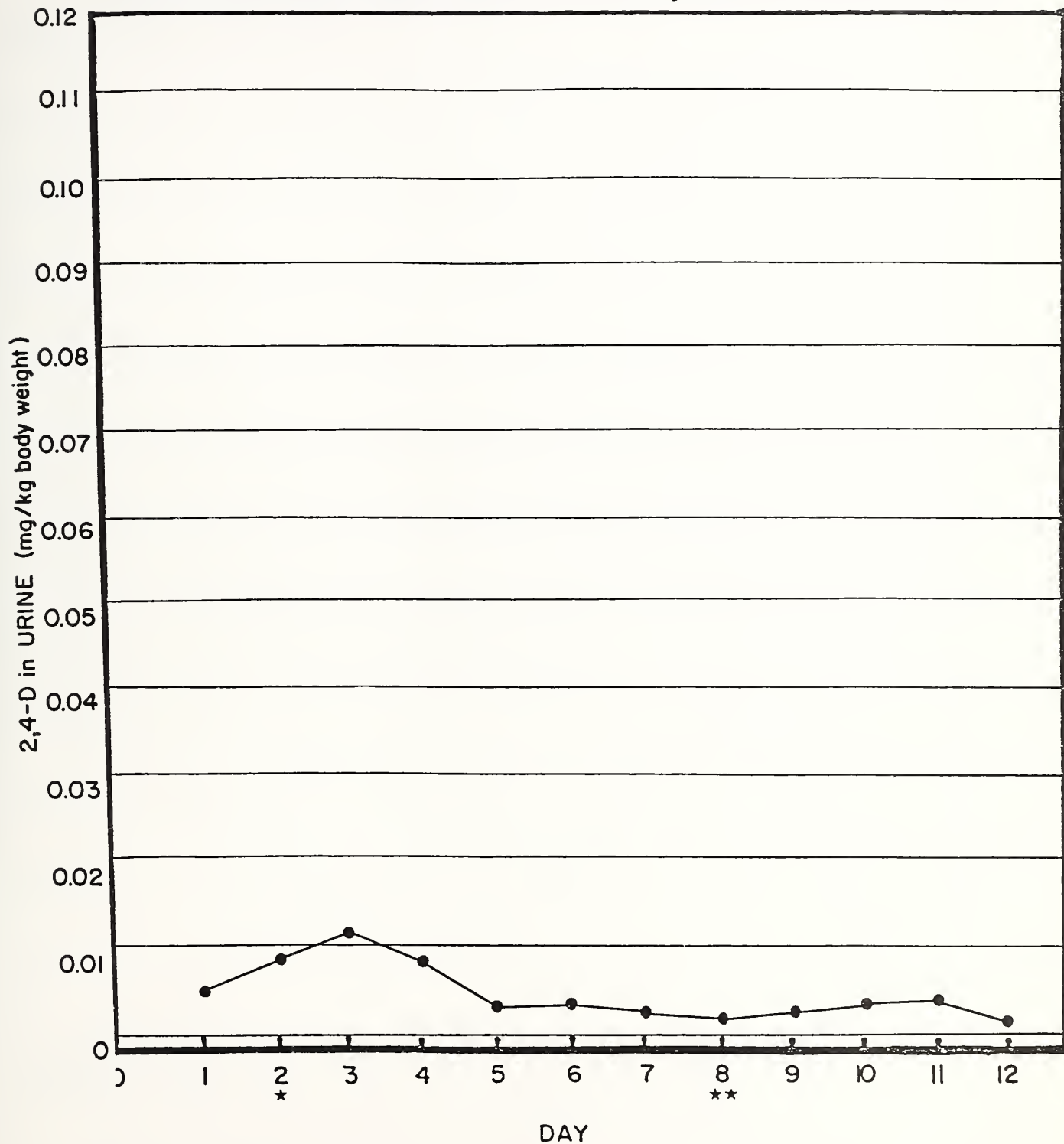


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

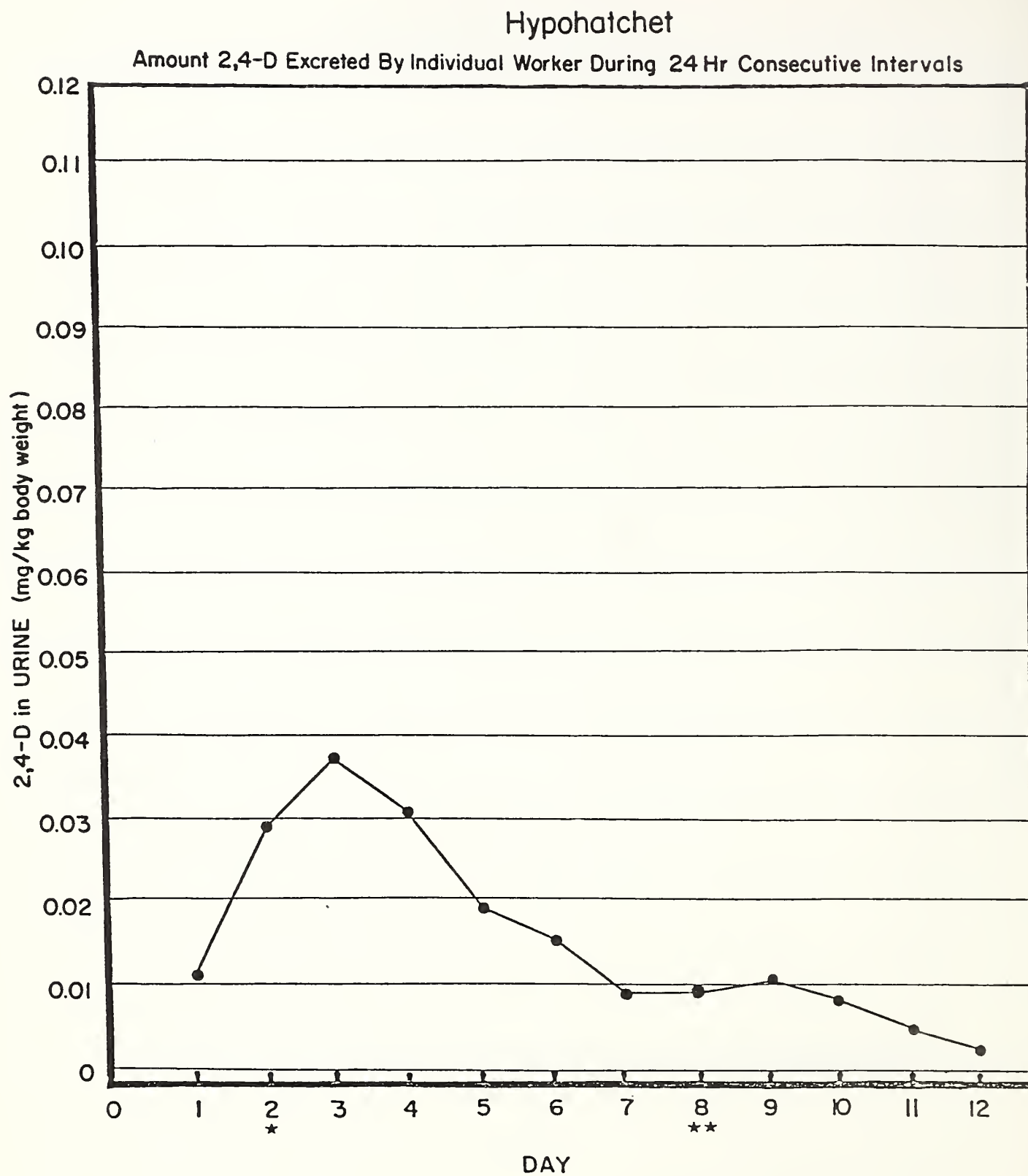
## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



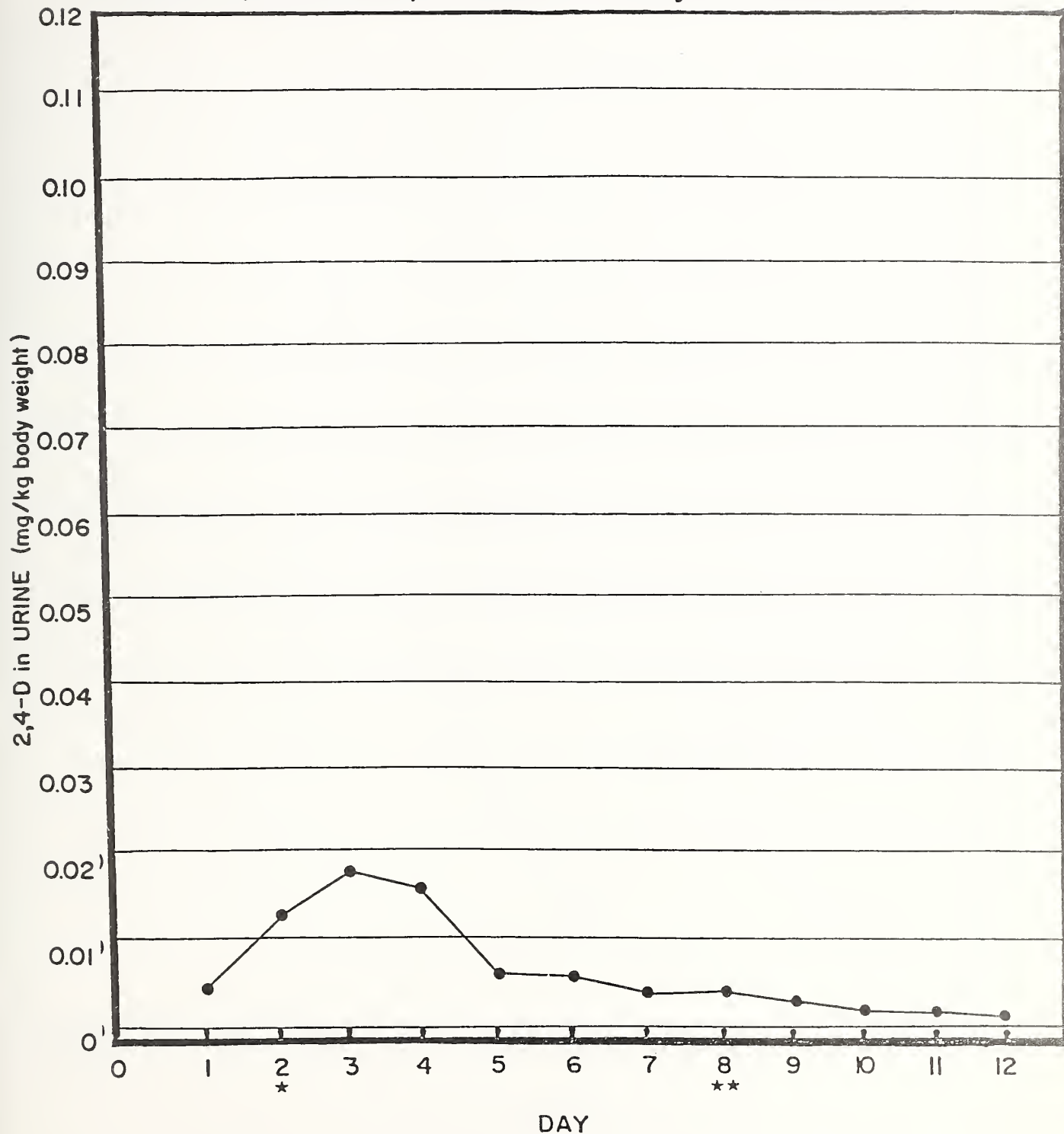
★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed



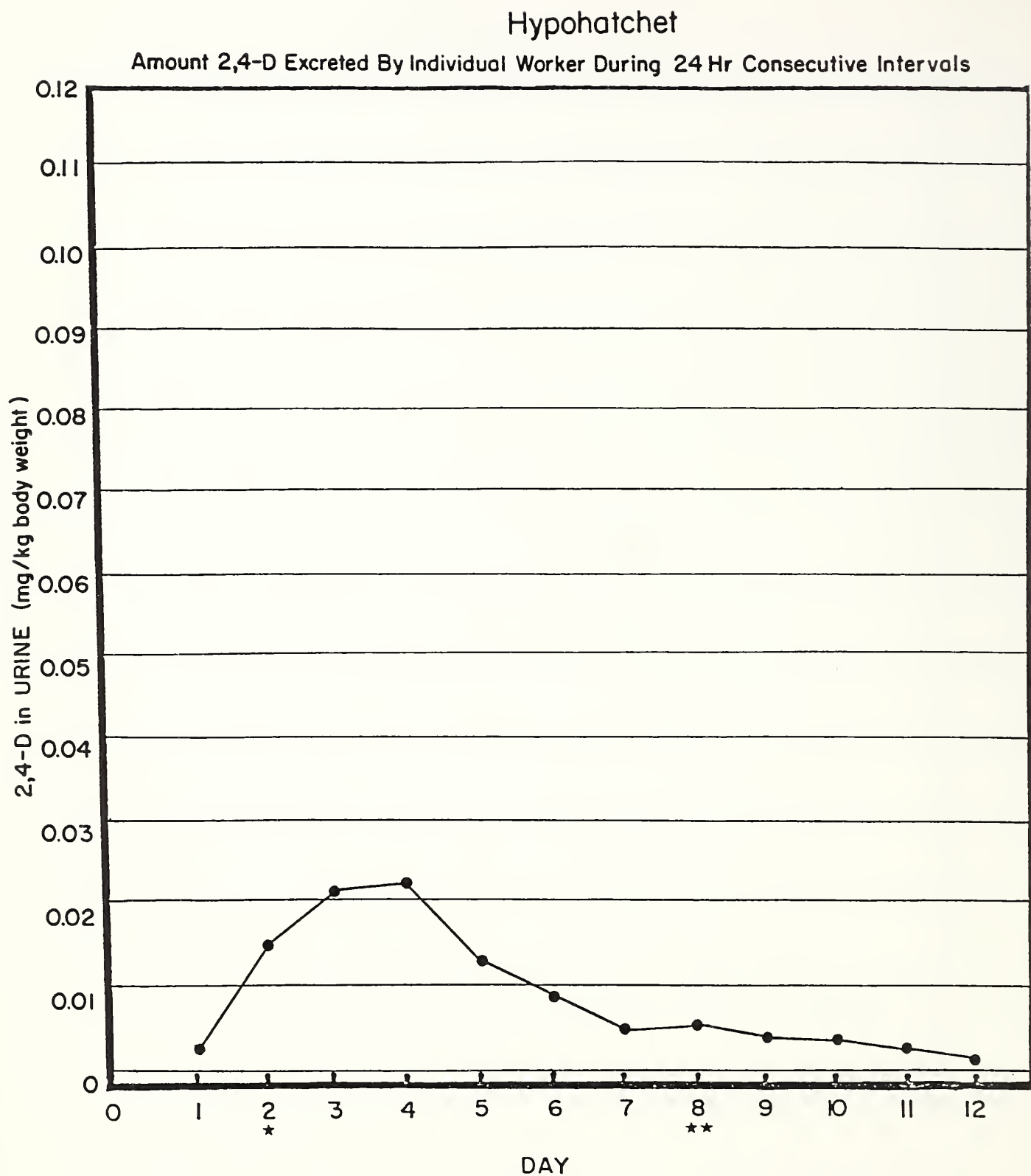
## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

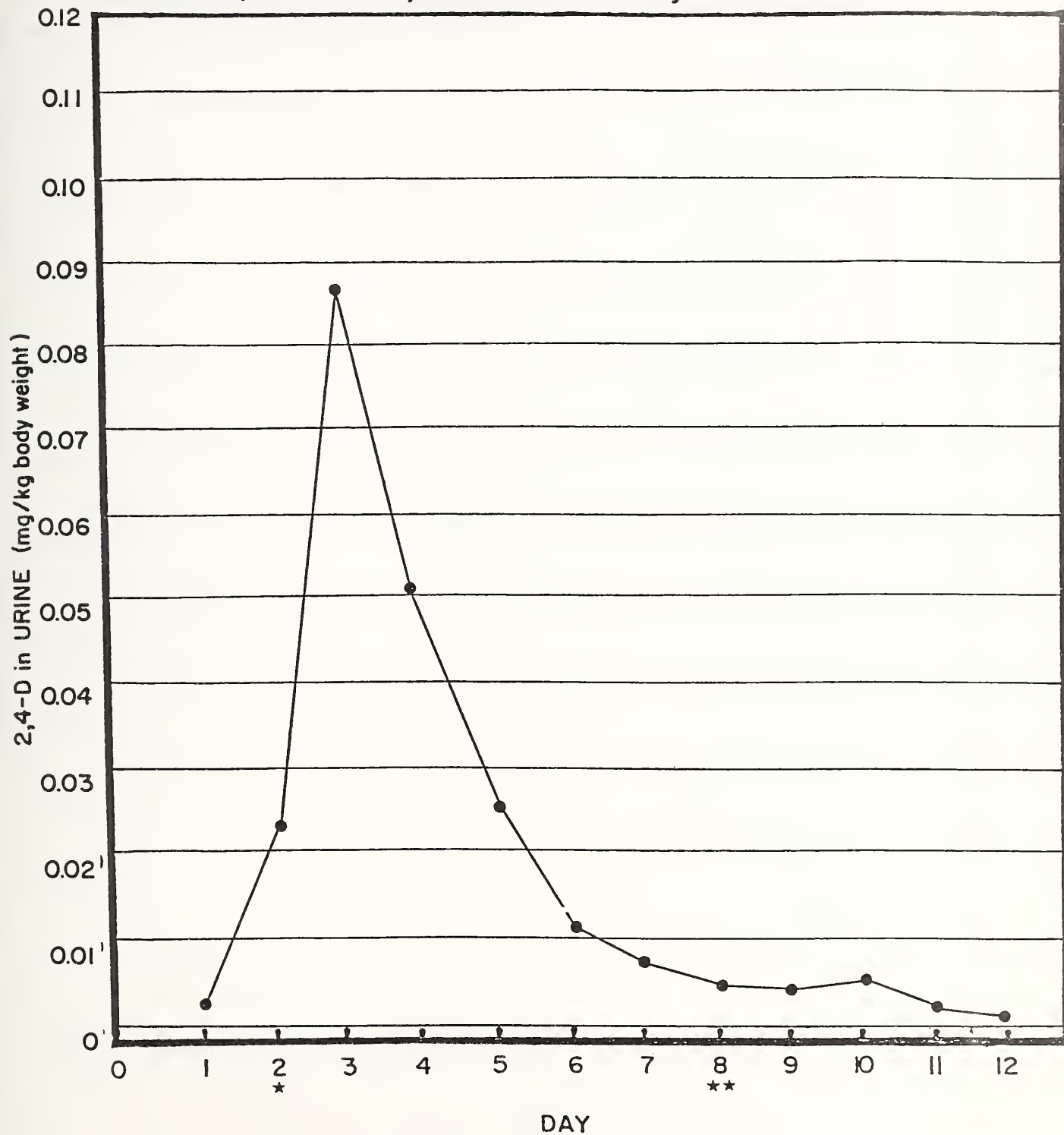


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

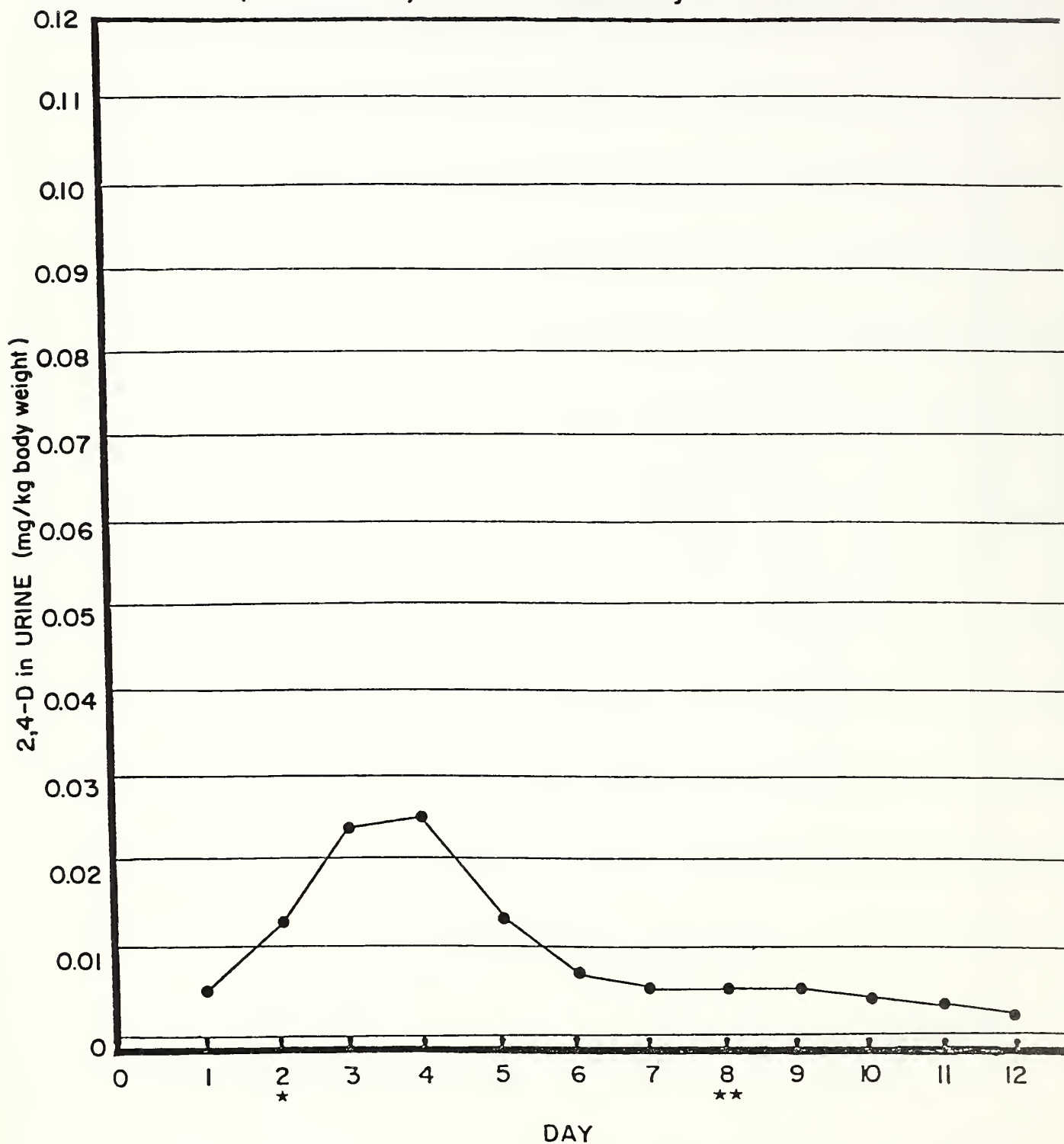


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

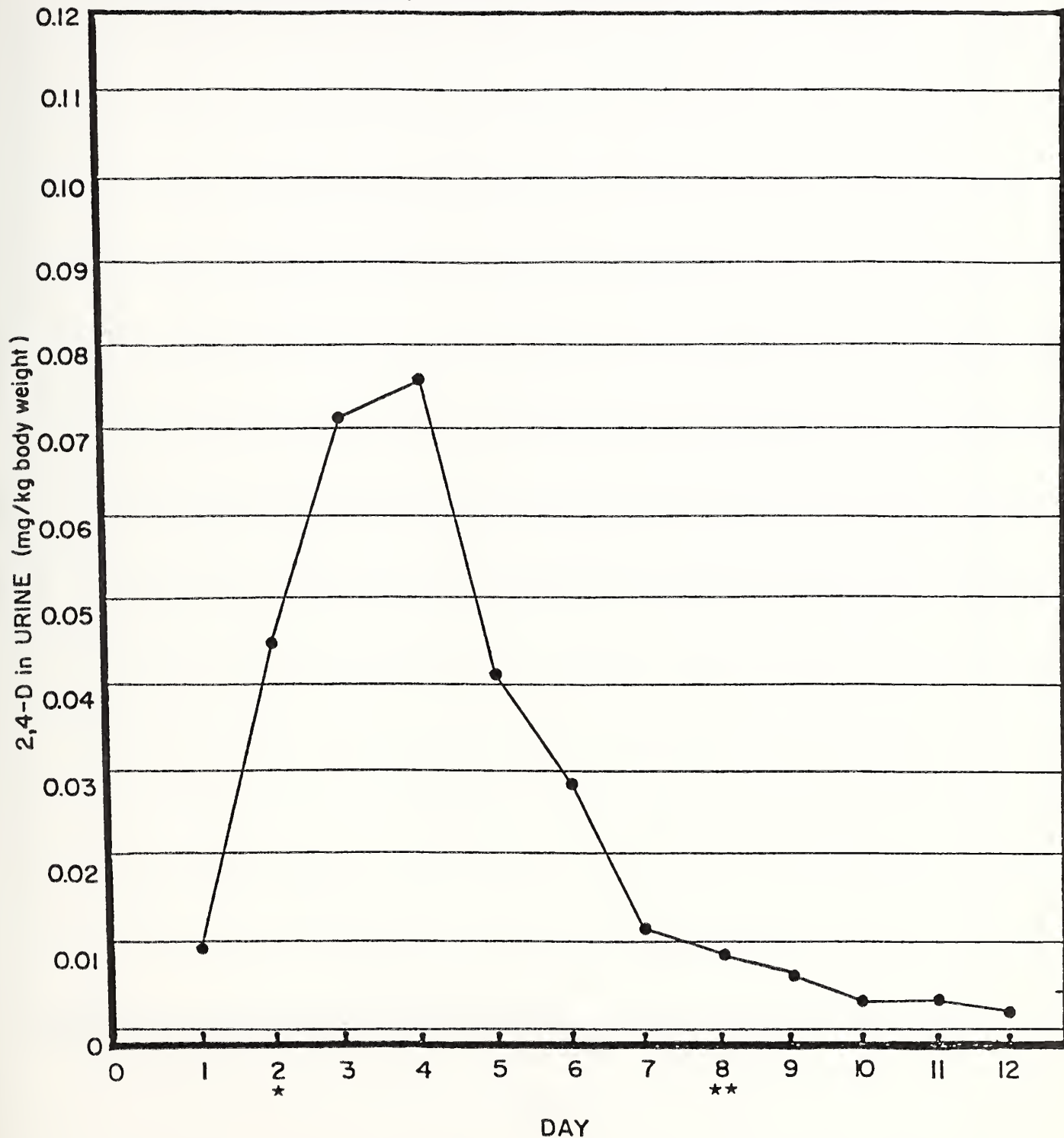


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

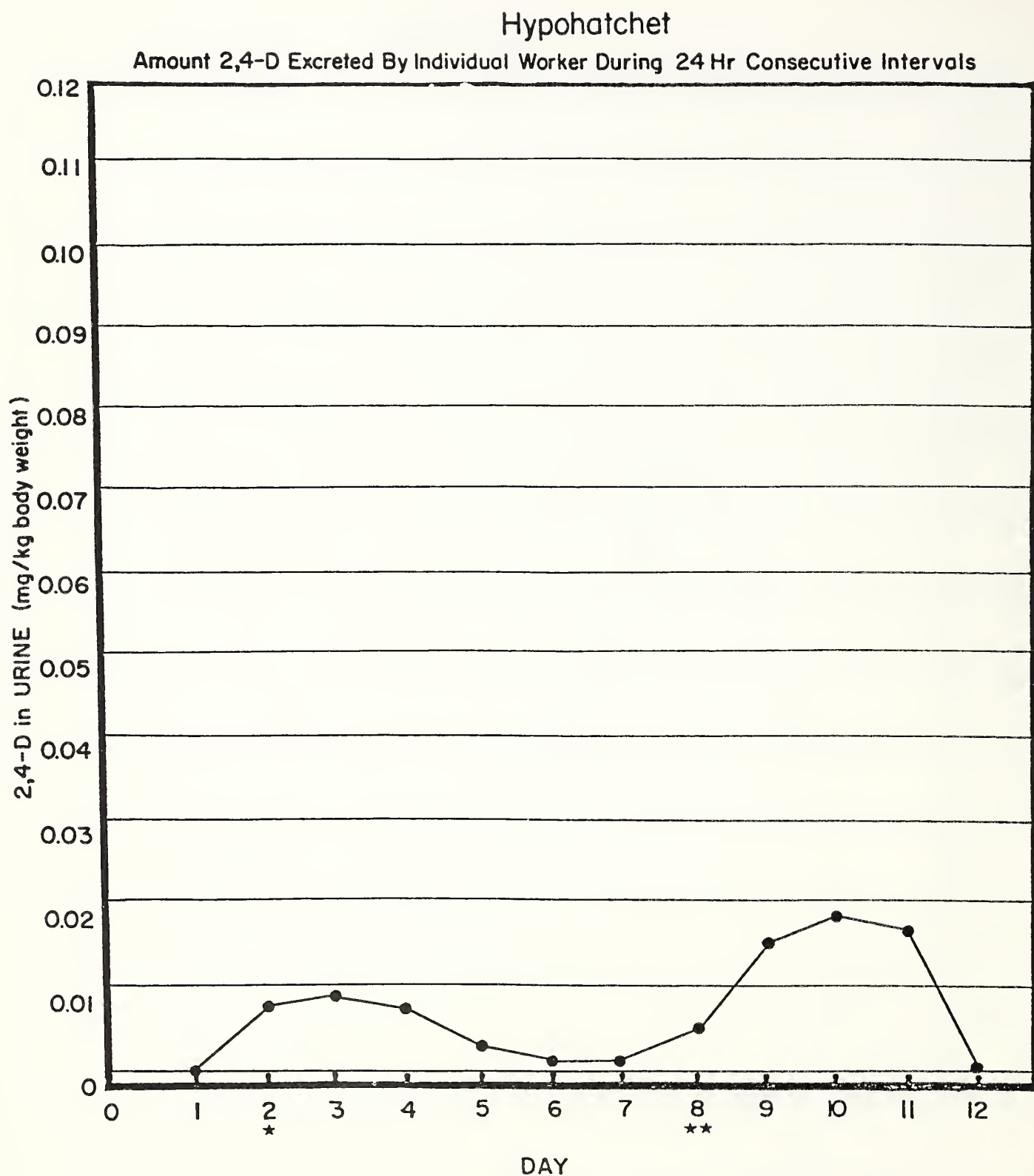
Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

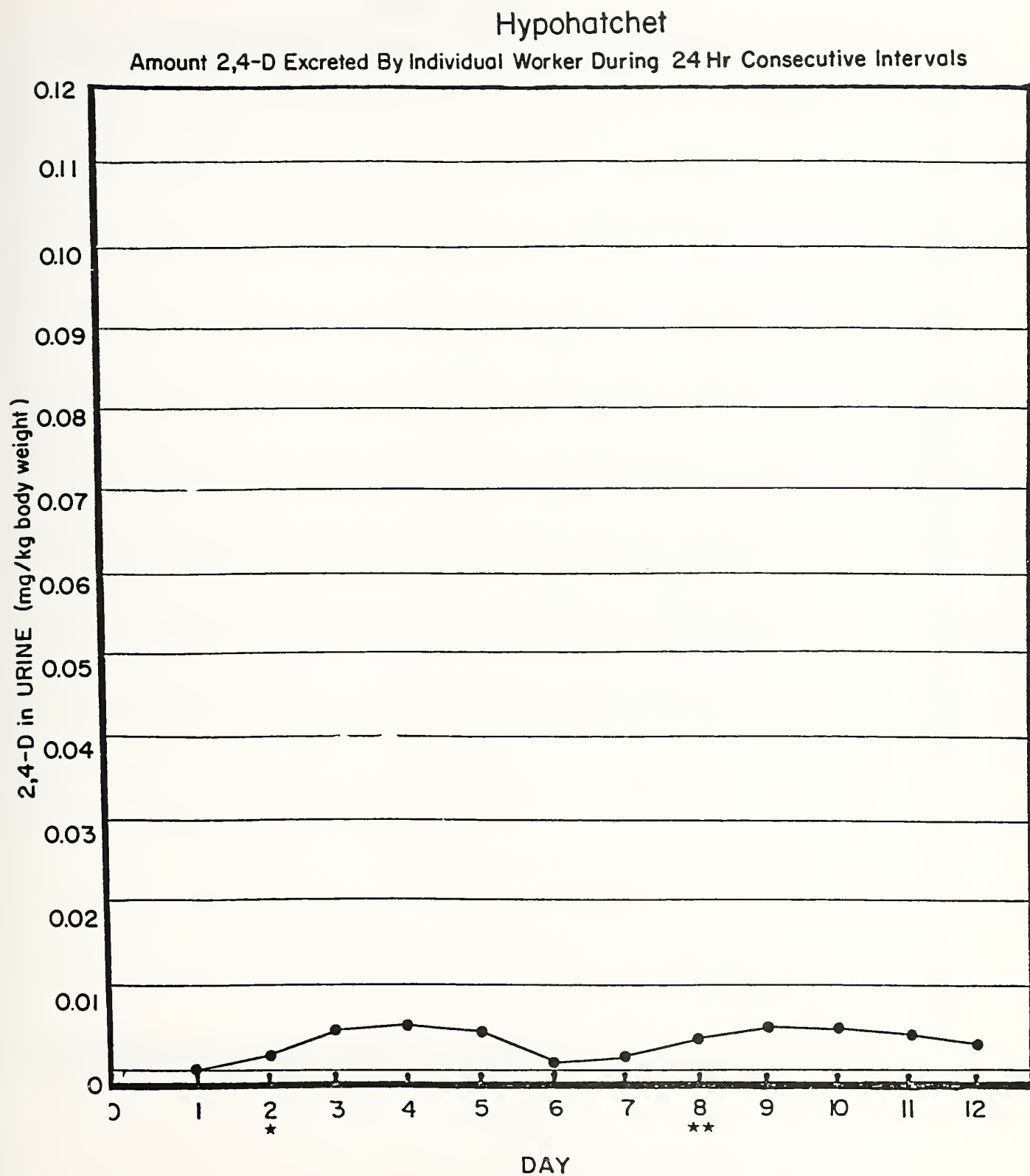
\*\* Treatment 2 - Special precautions observed





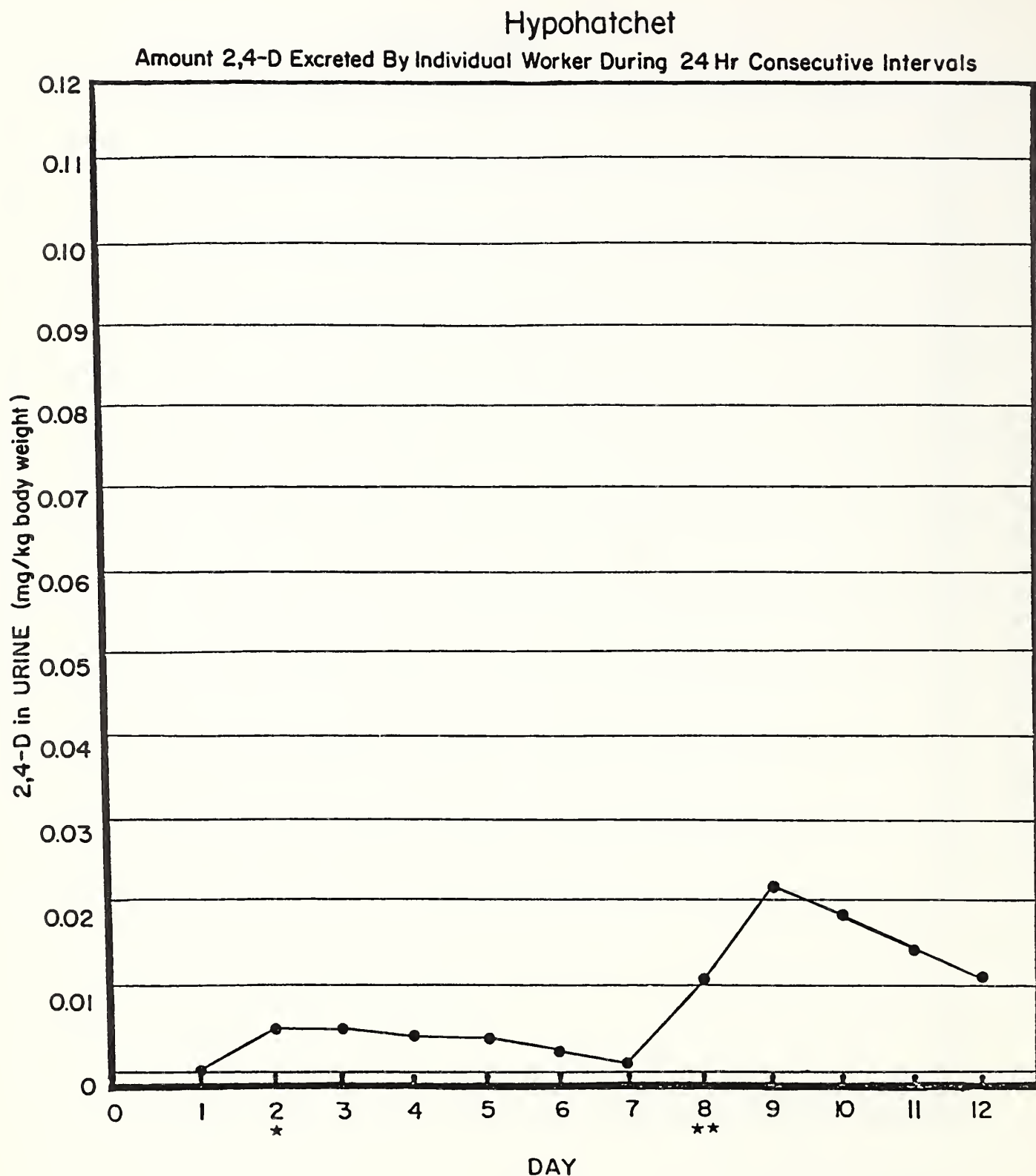
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

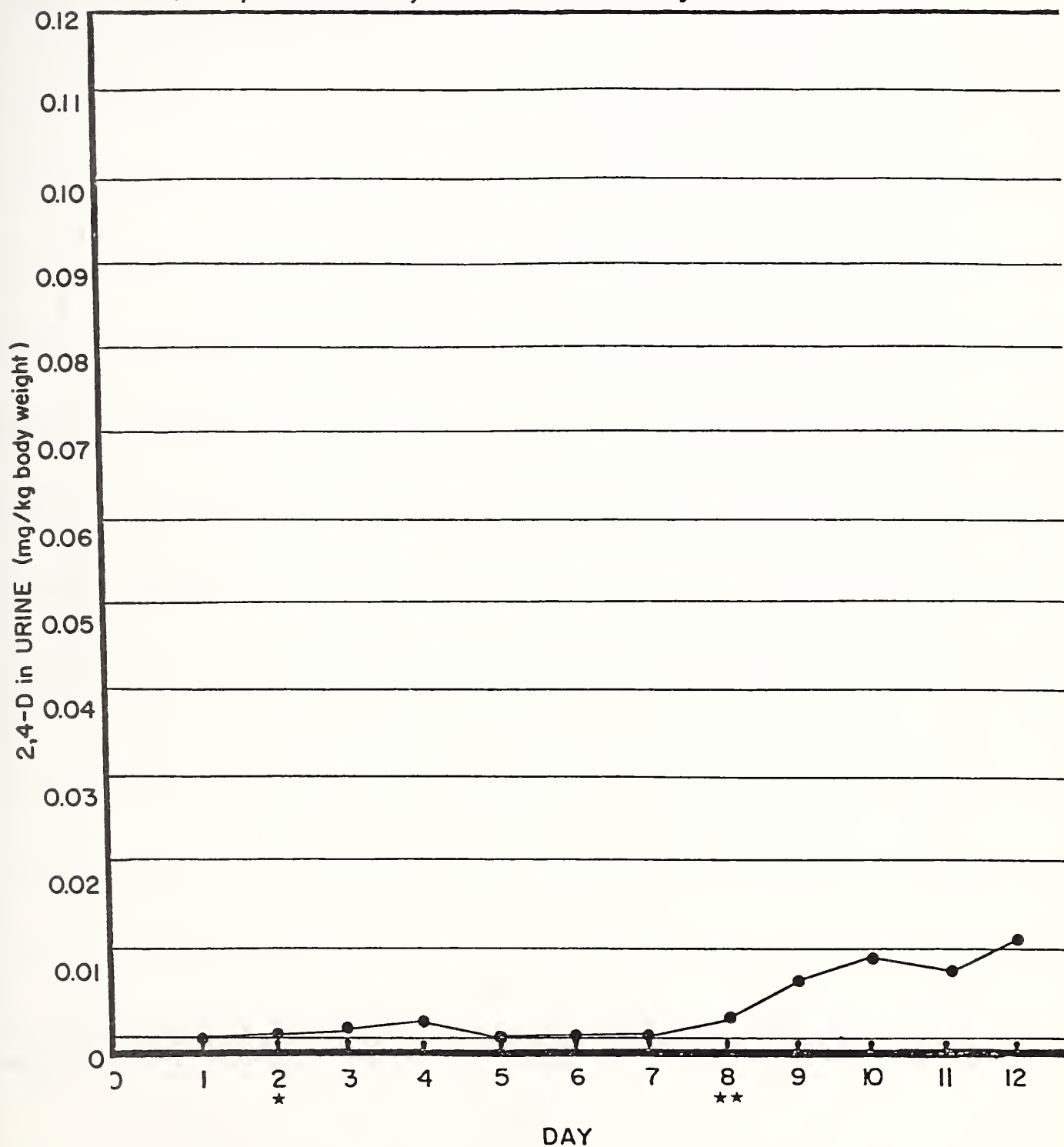


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

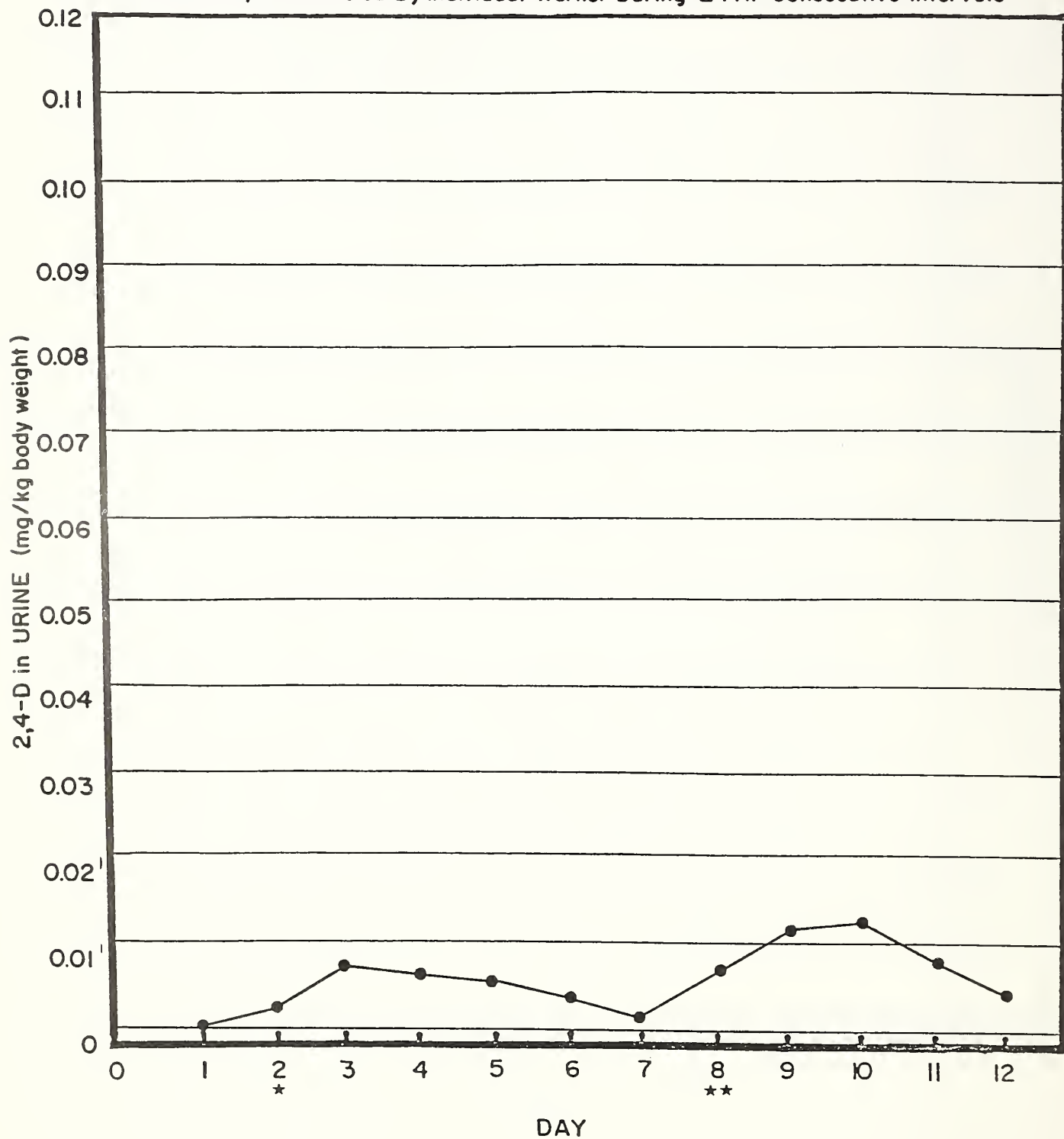


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

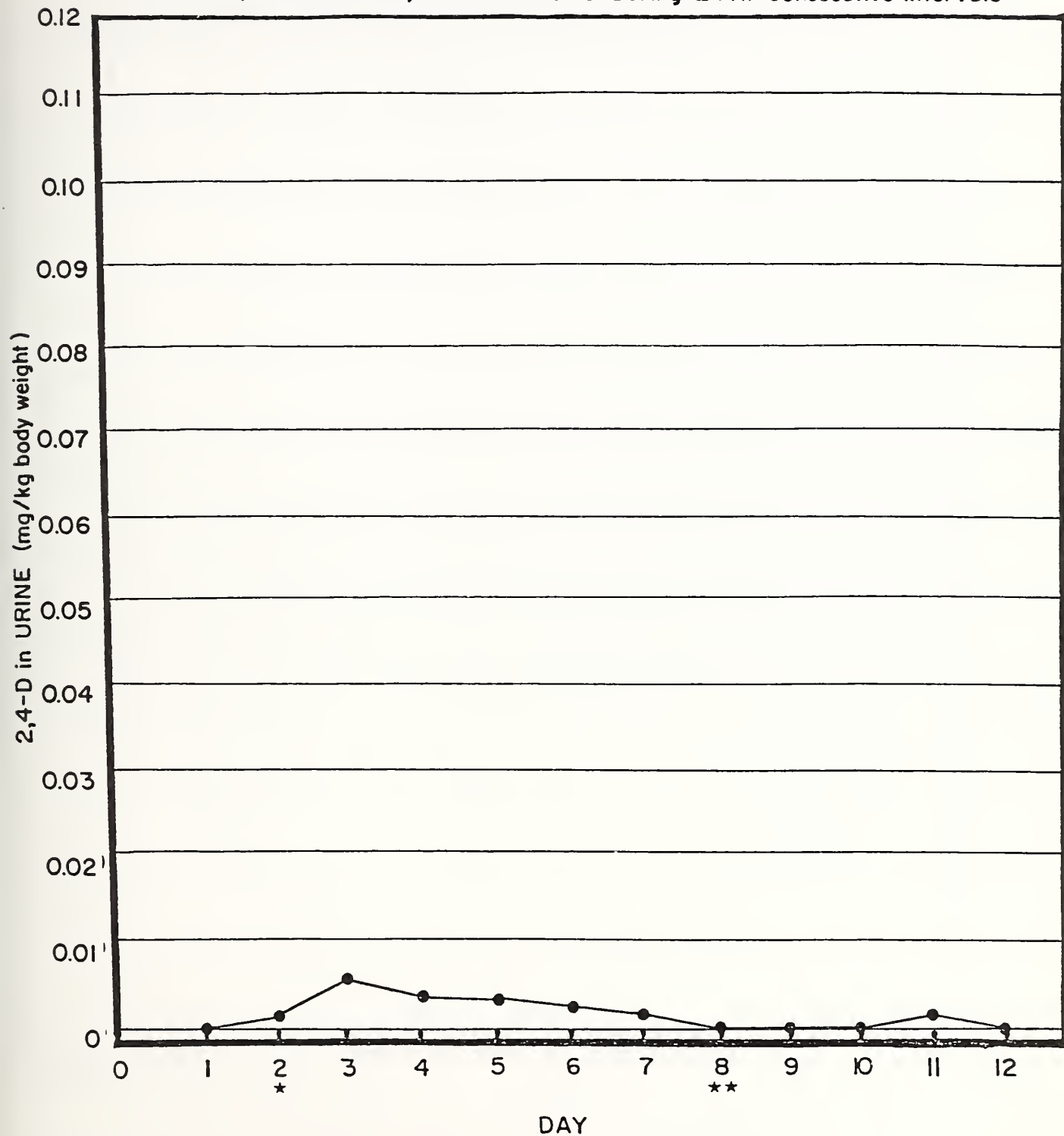


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



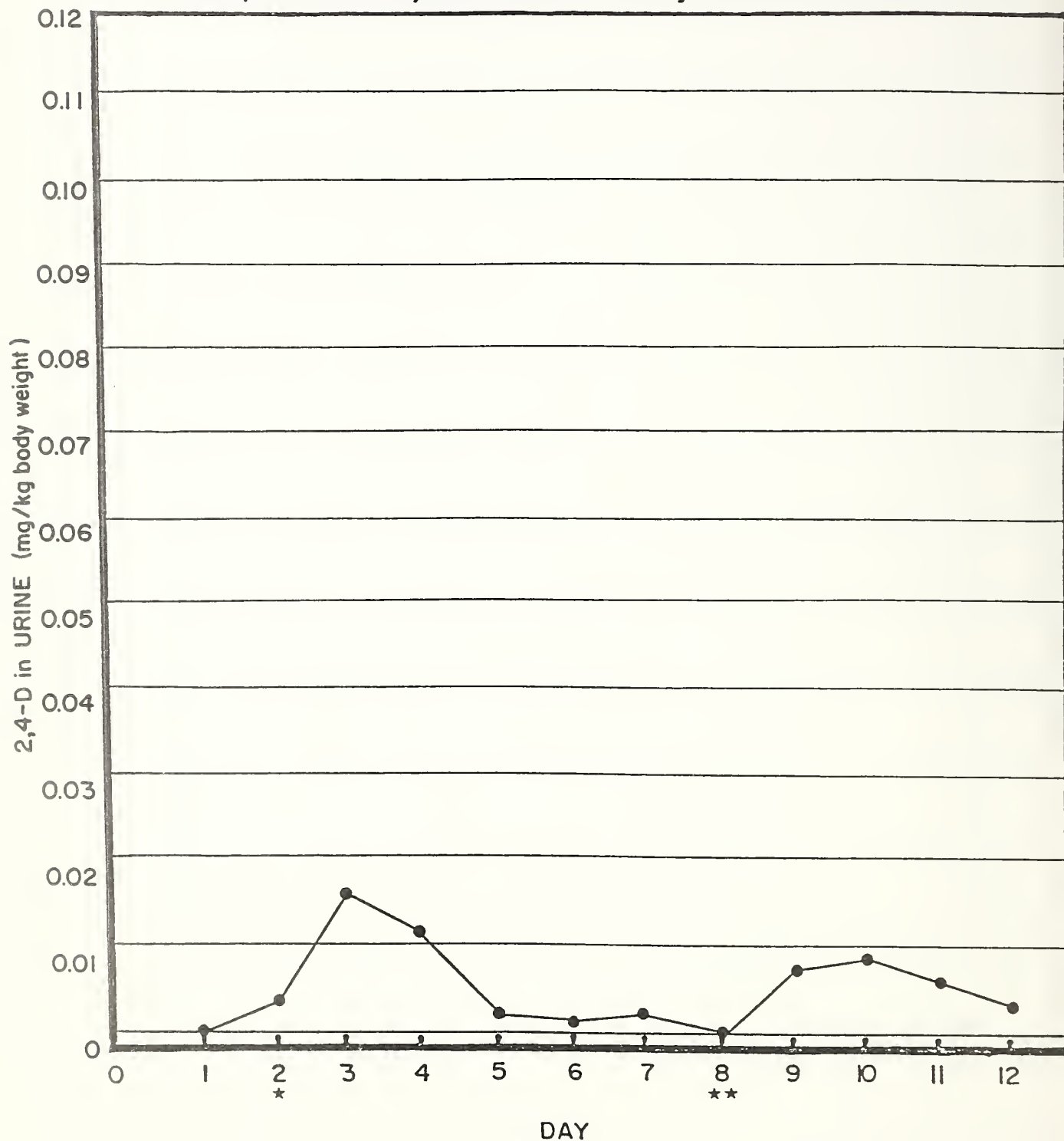
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

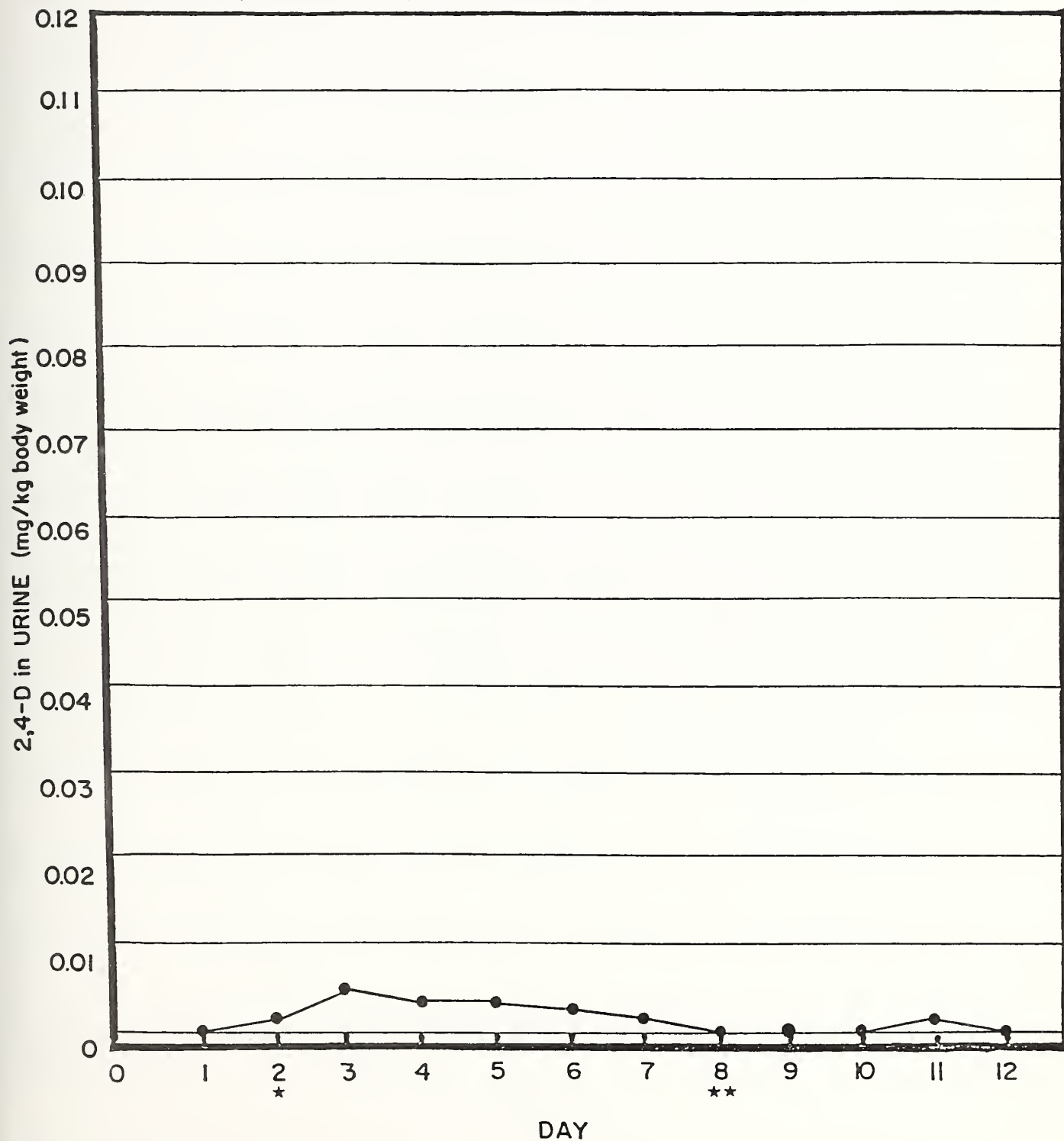


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

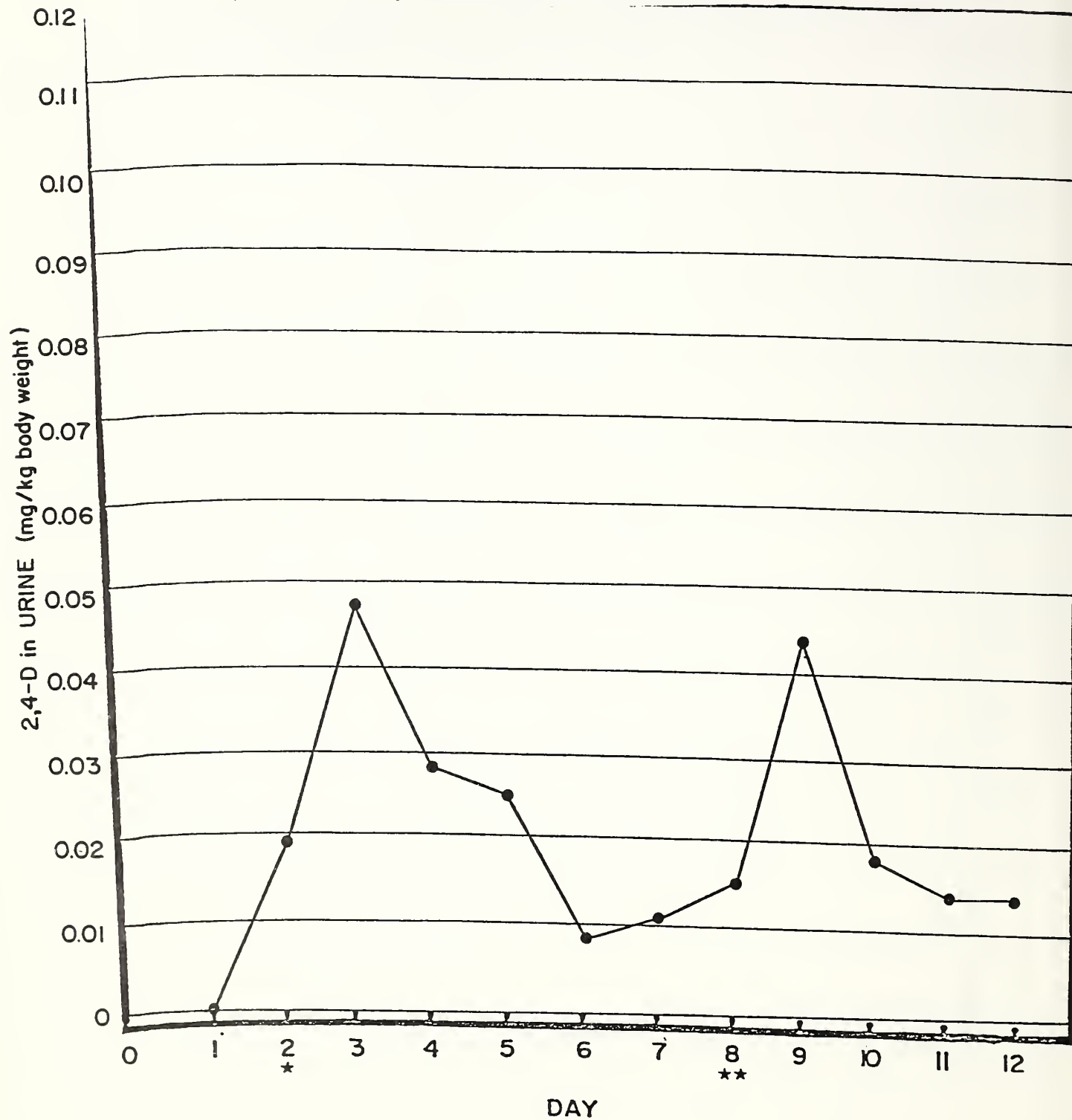


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

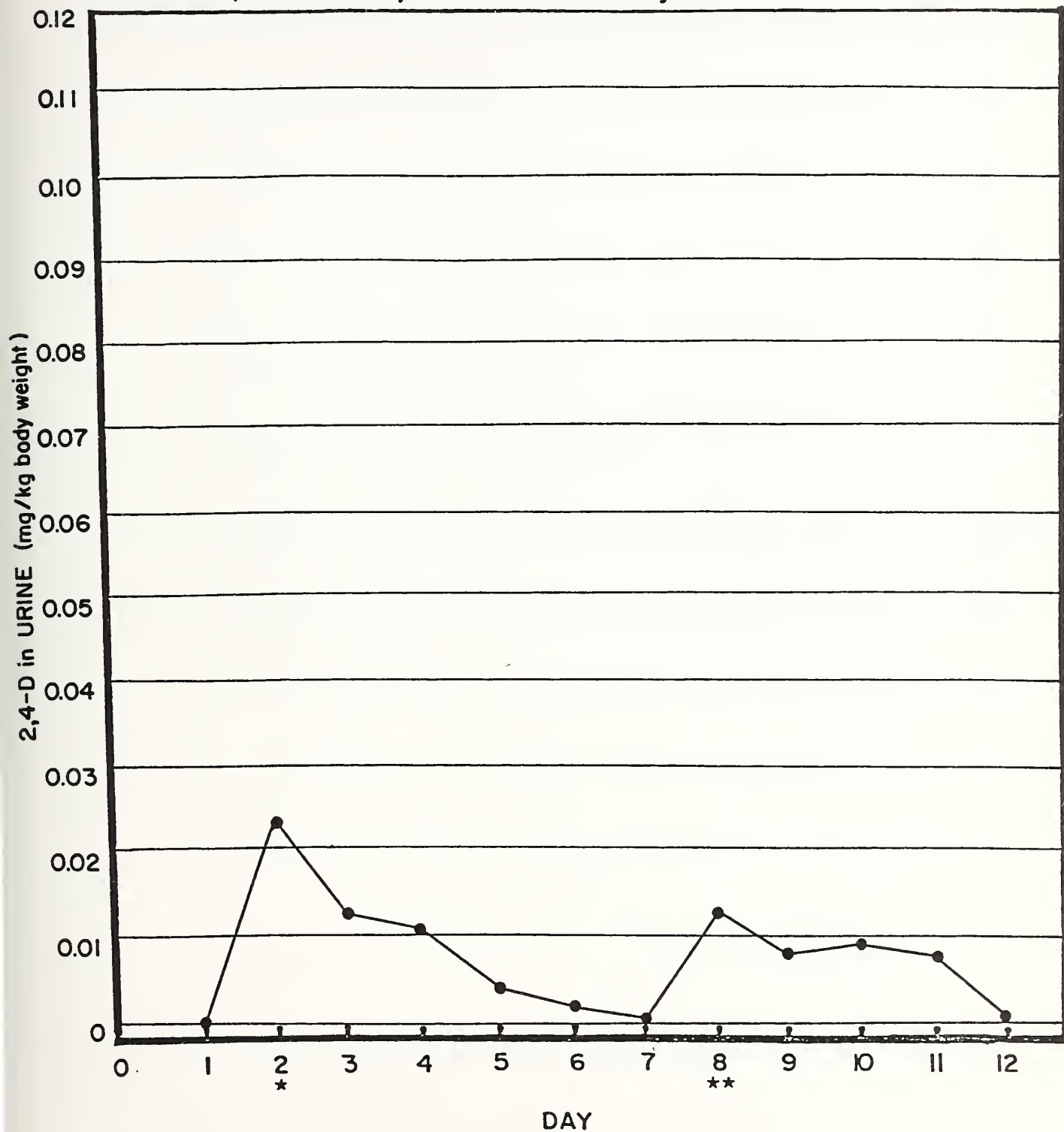


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

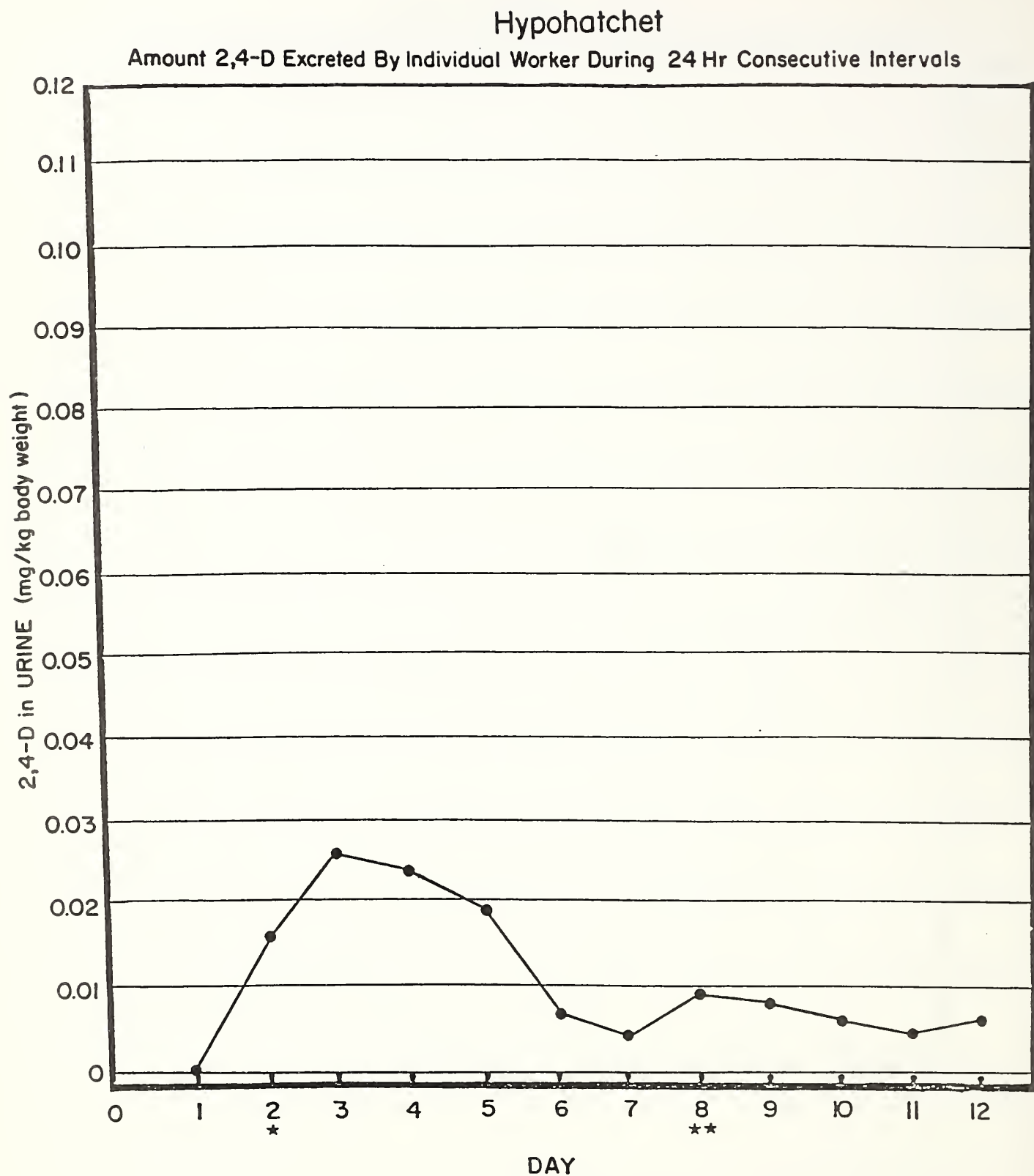
## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

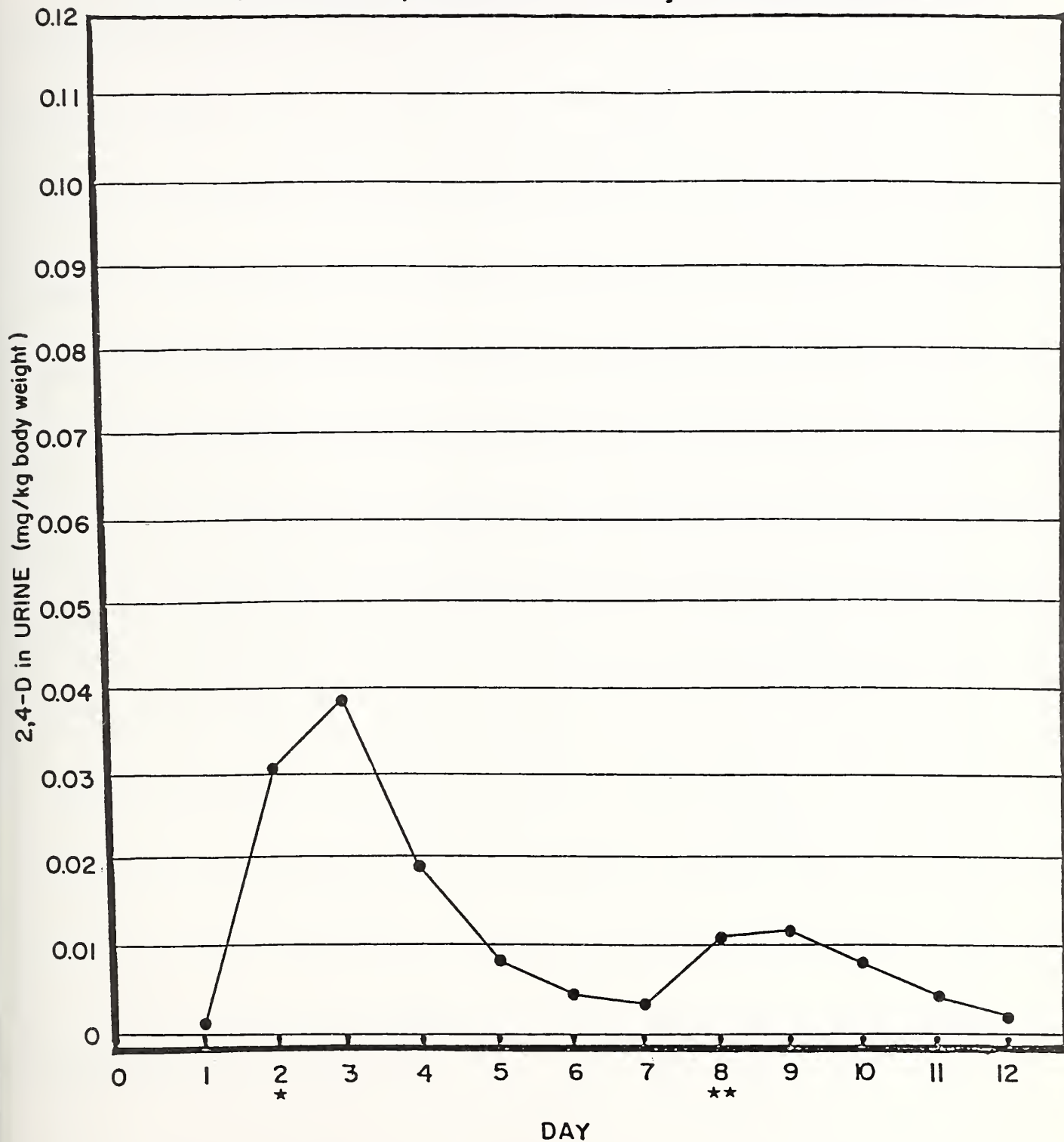


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



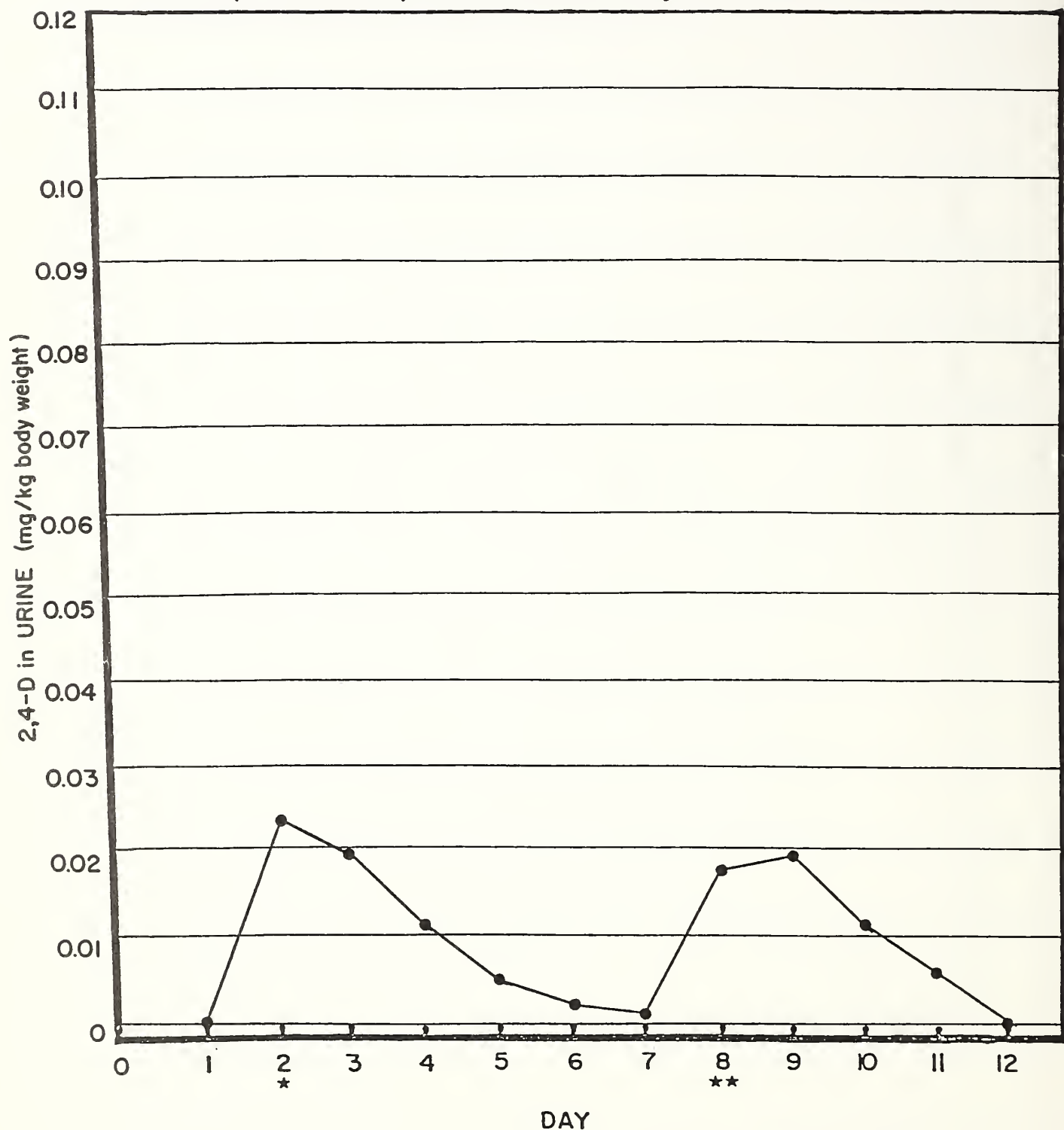
★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed



## Hypohatchet

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

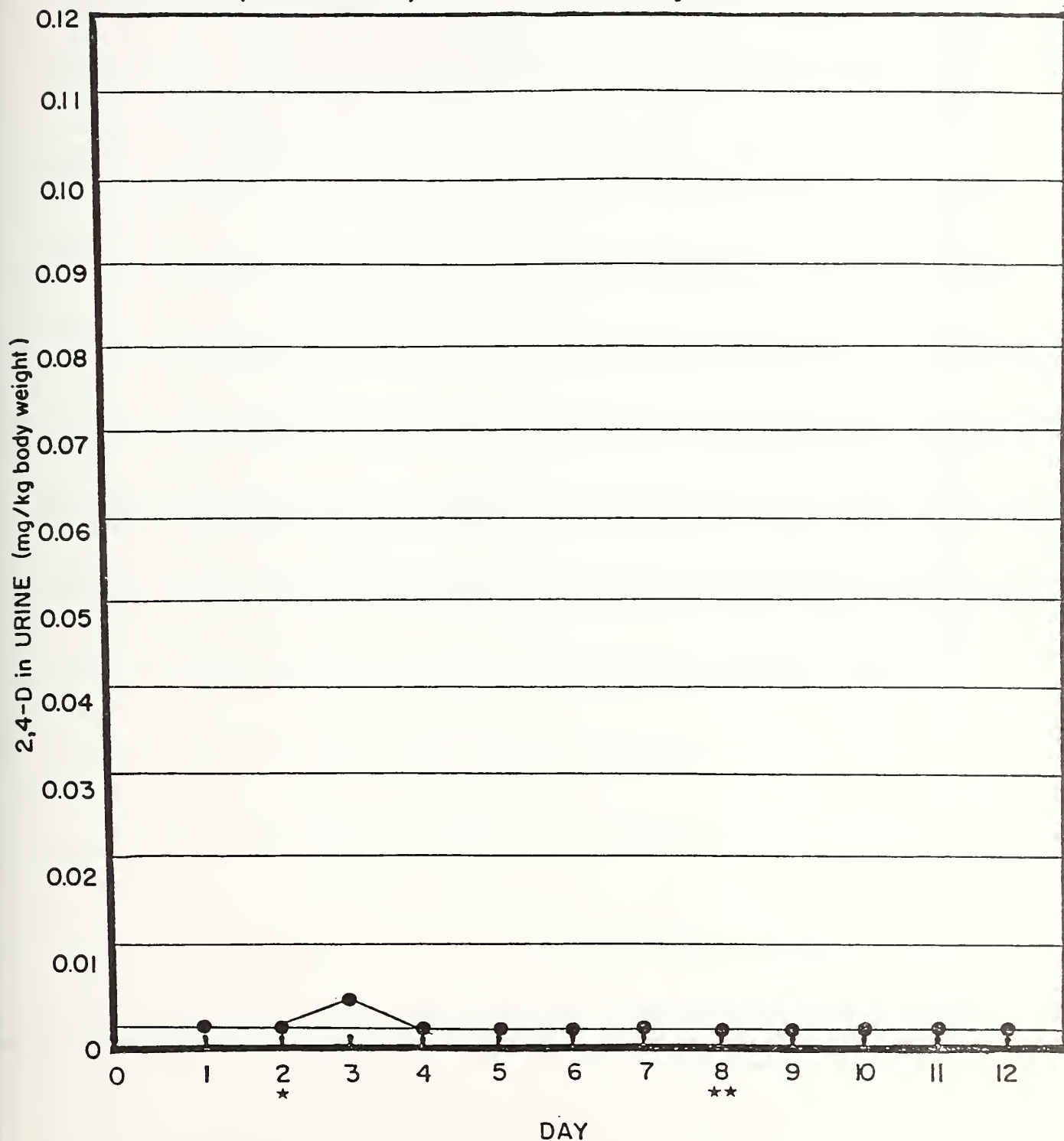


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

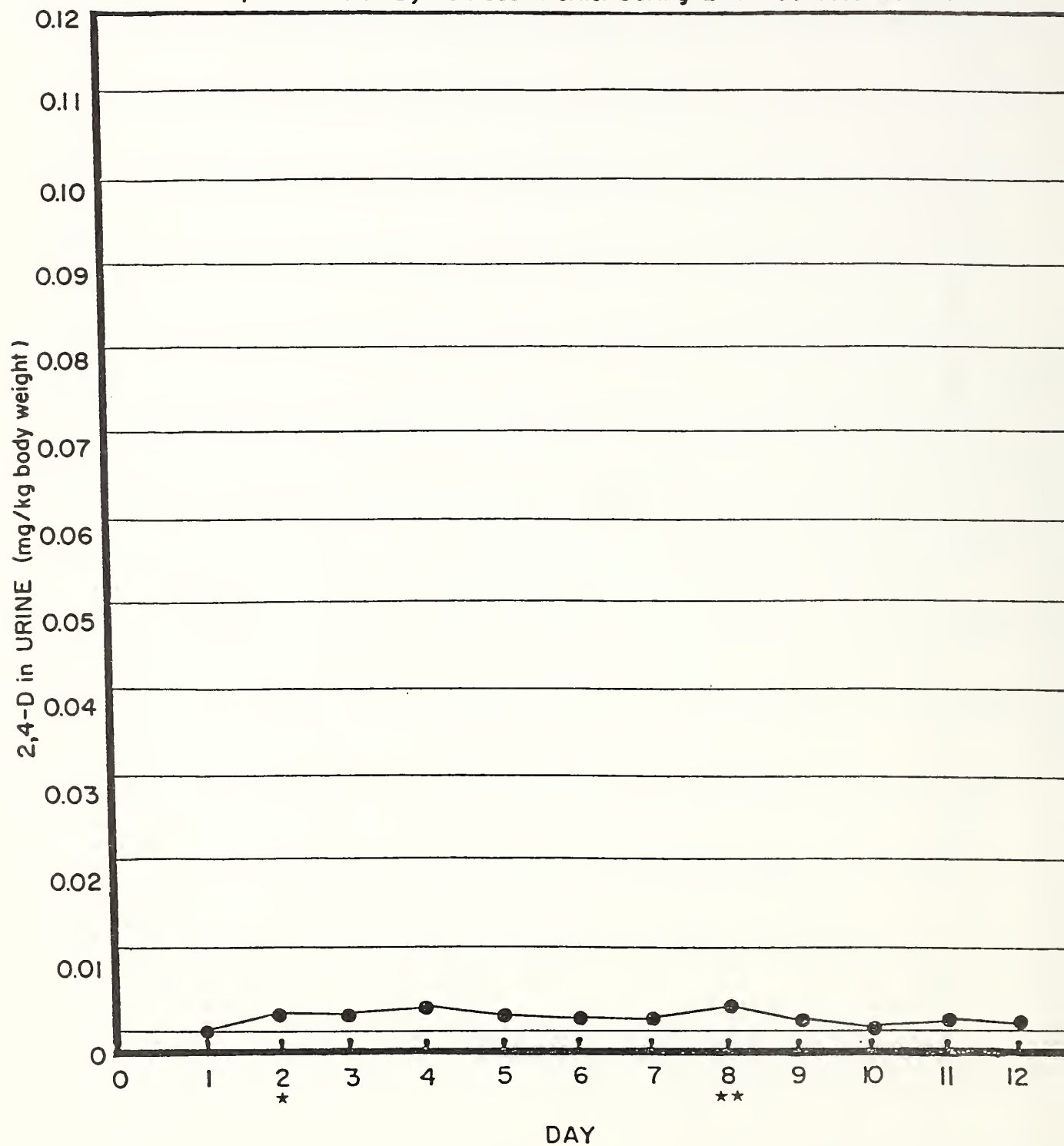


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

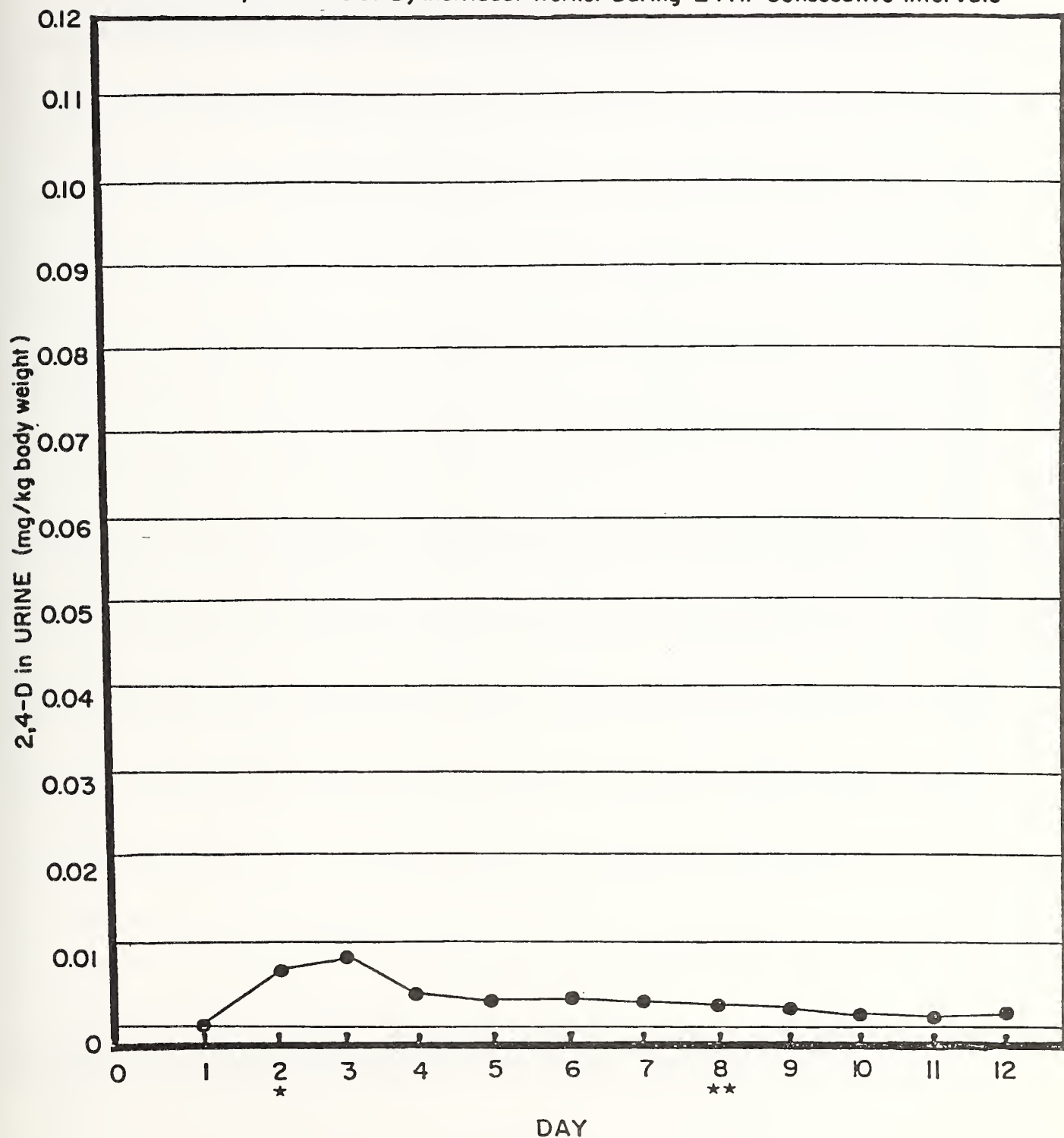
## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



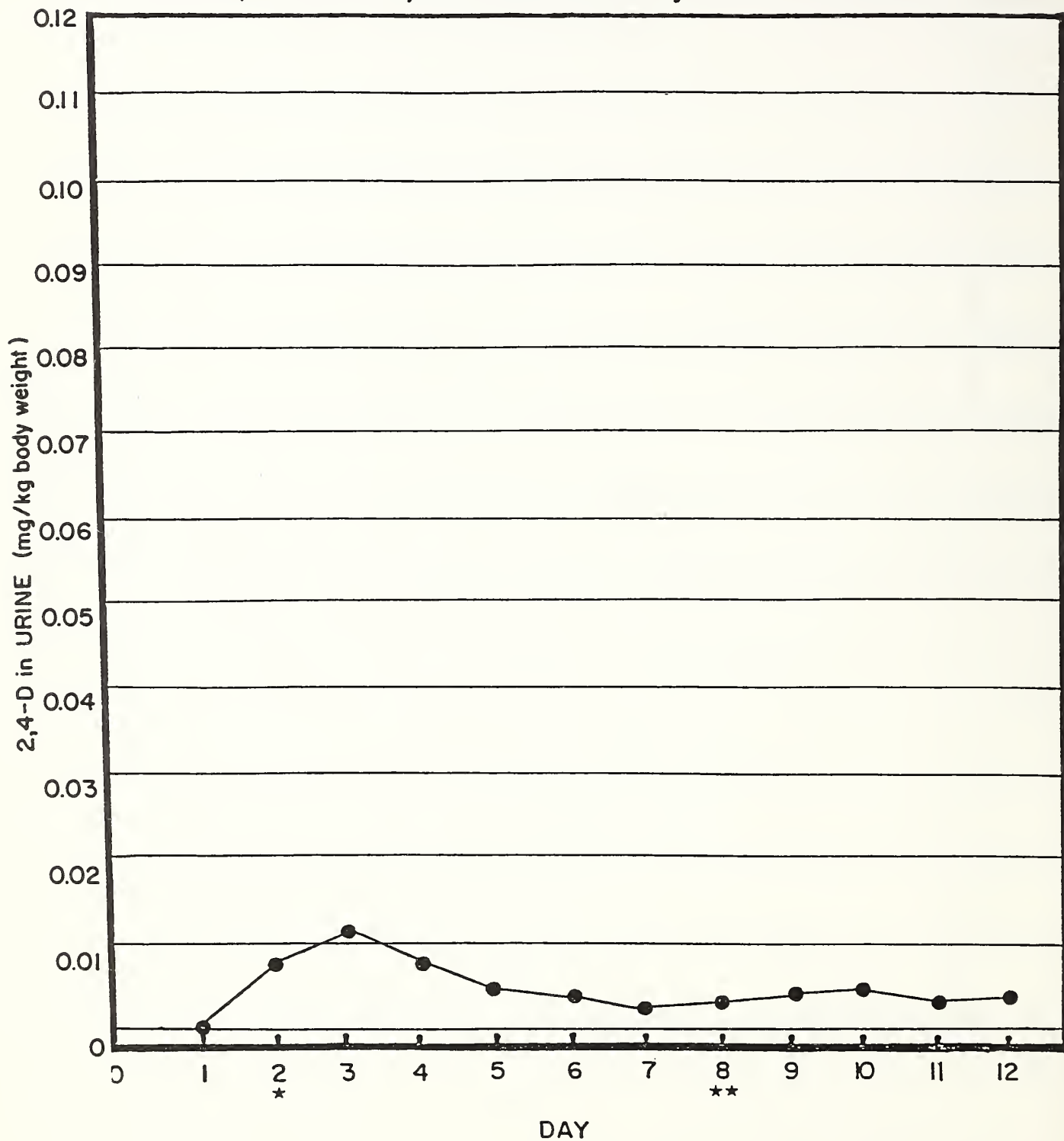
## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

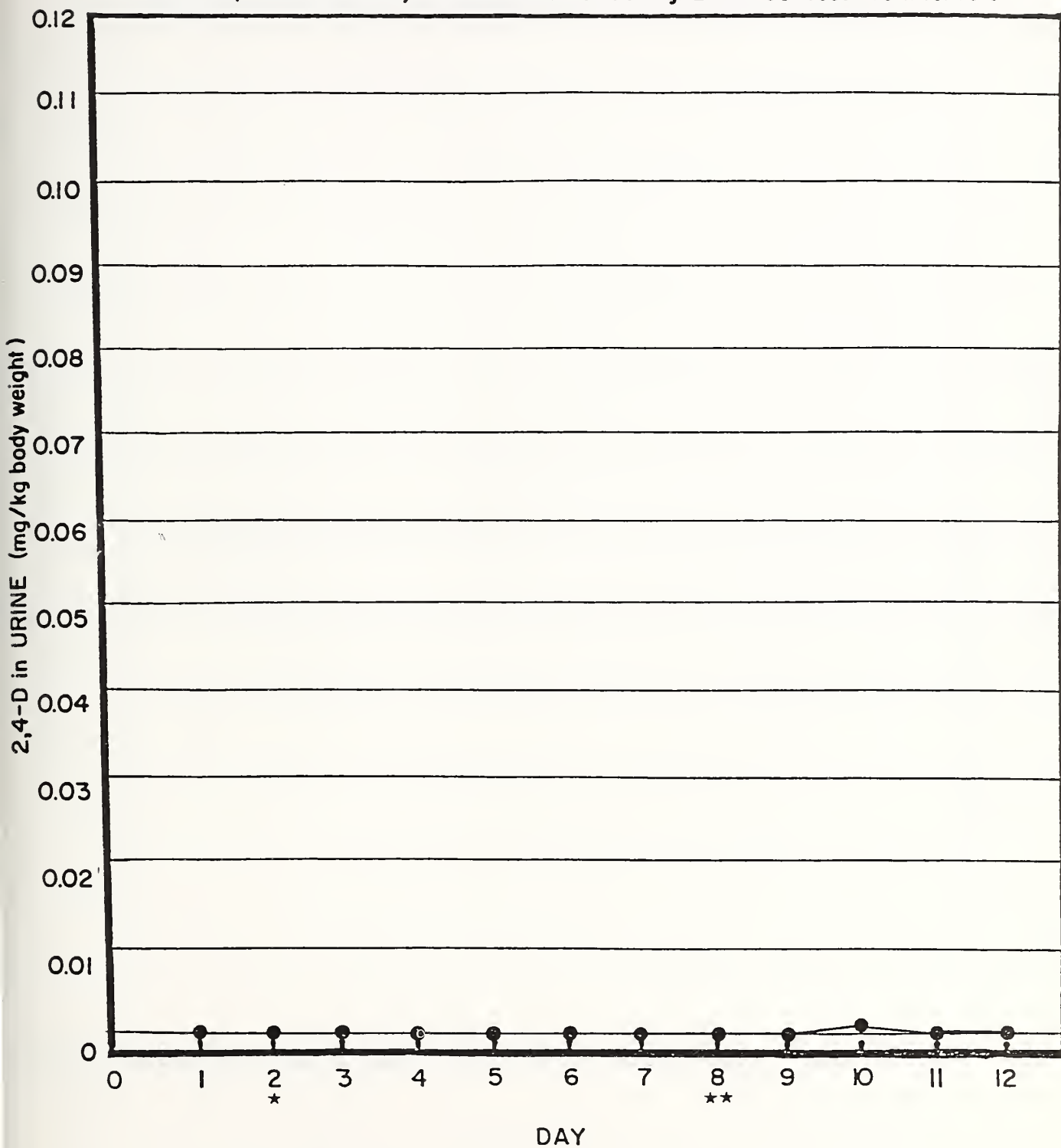


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



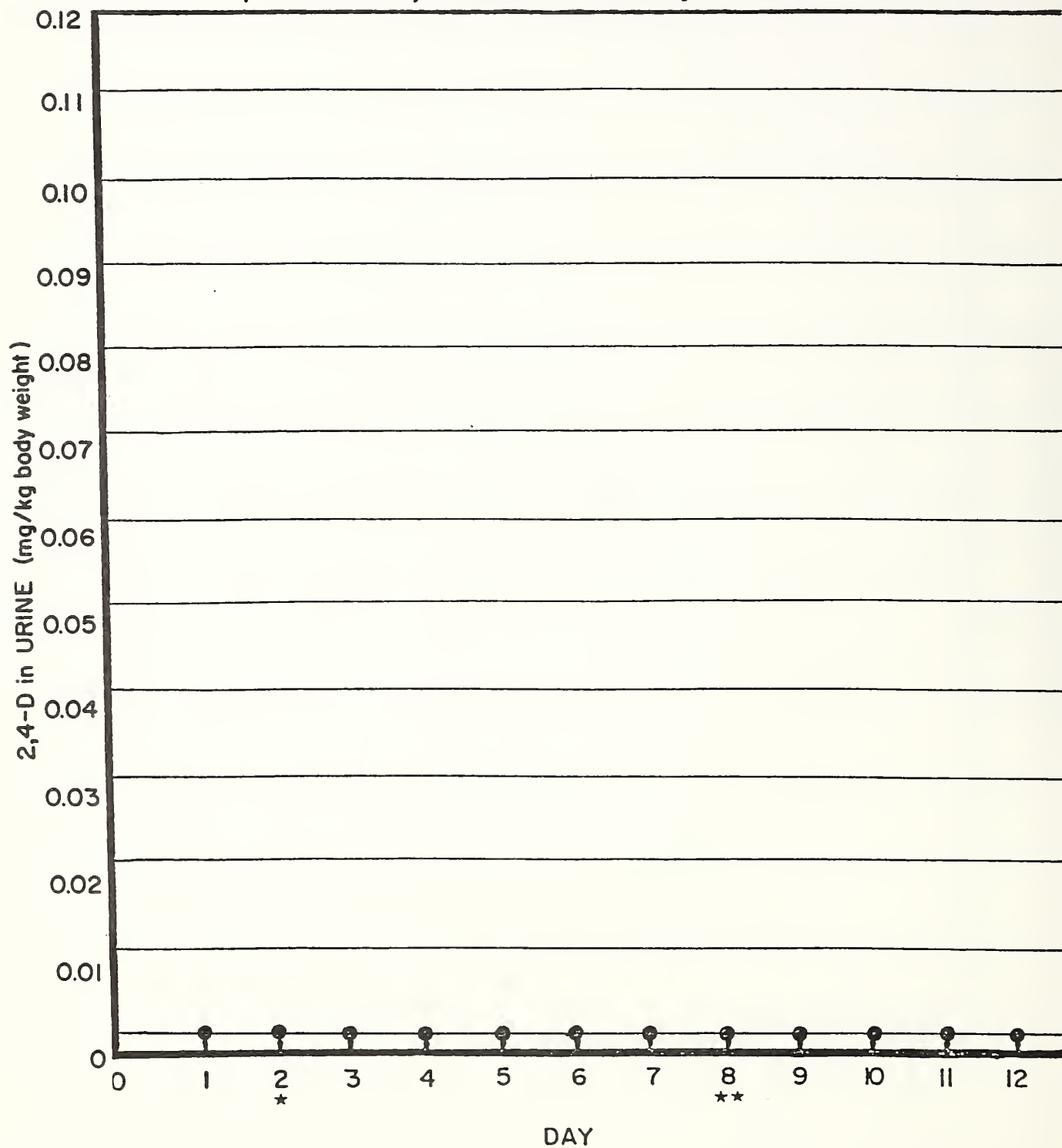
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

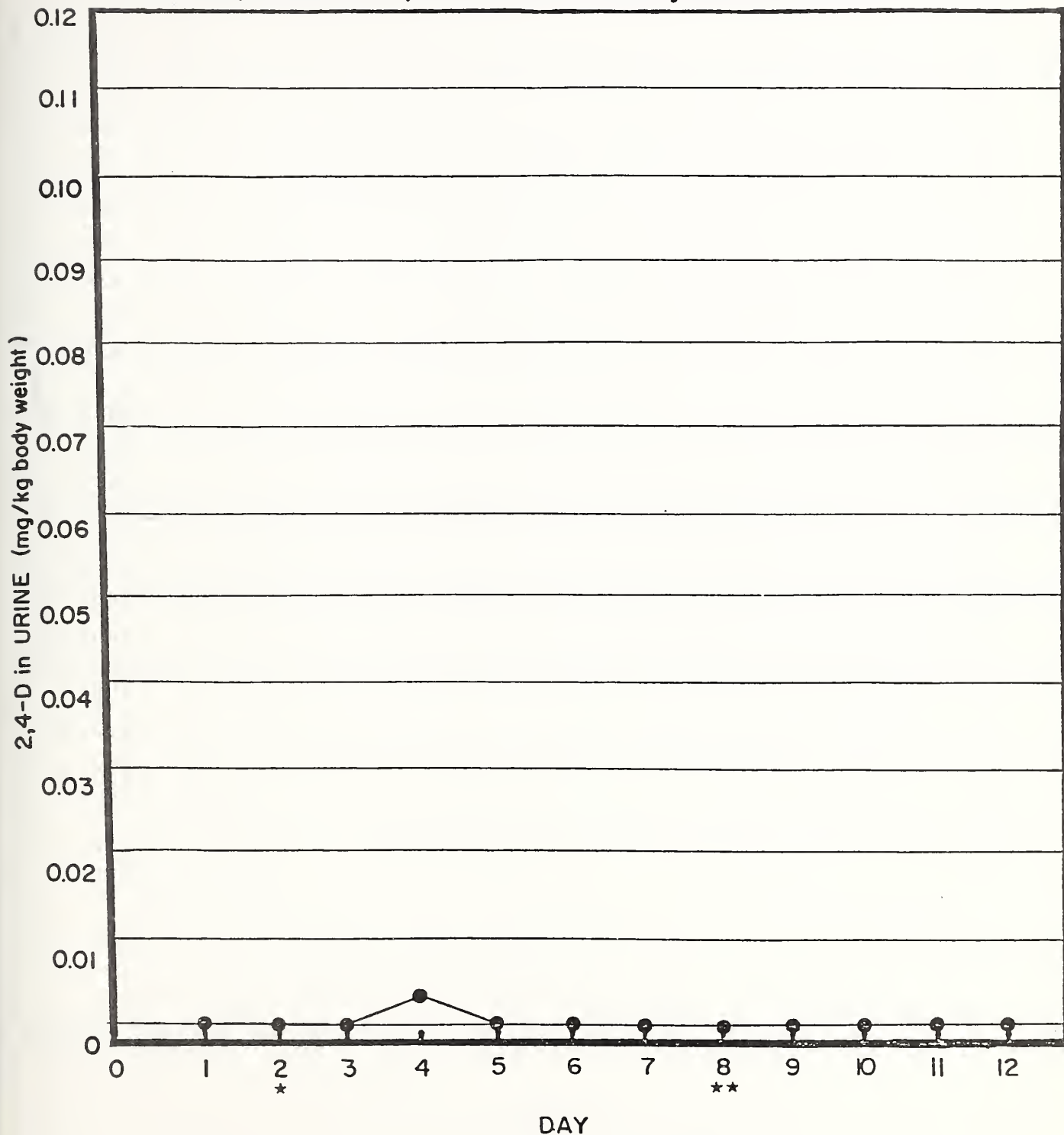


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

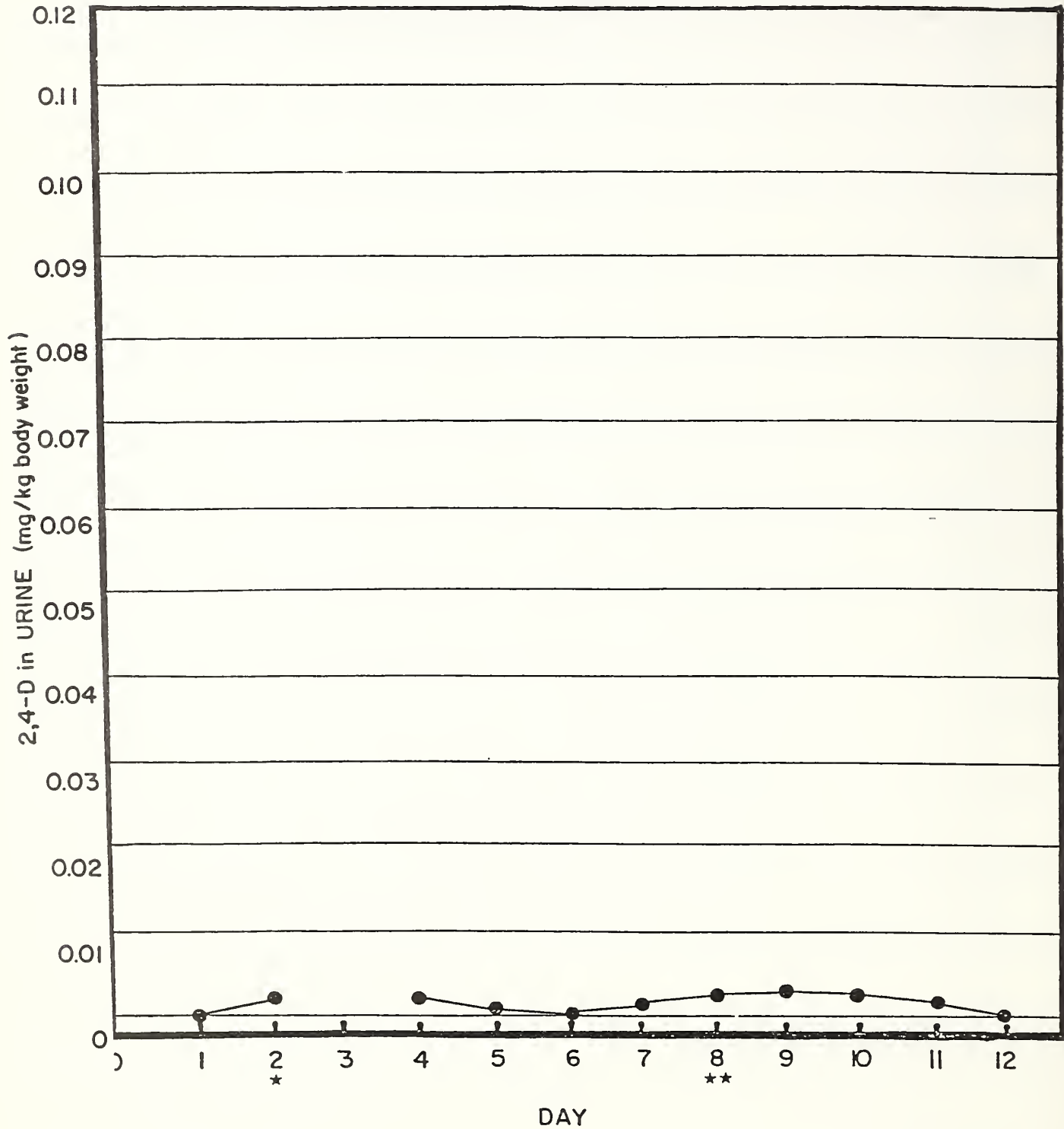


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

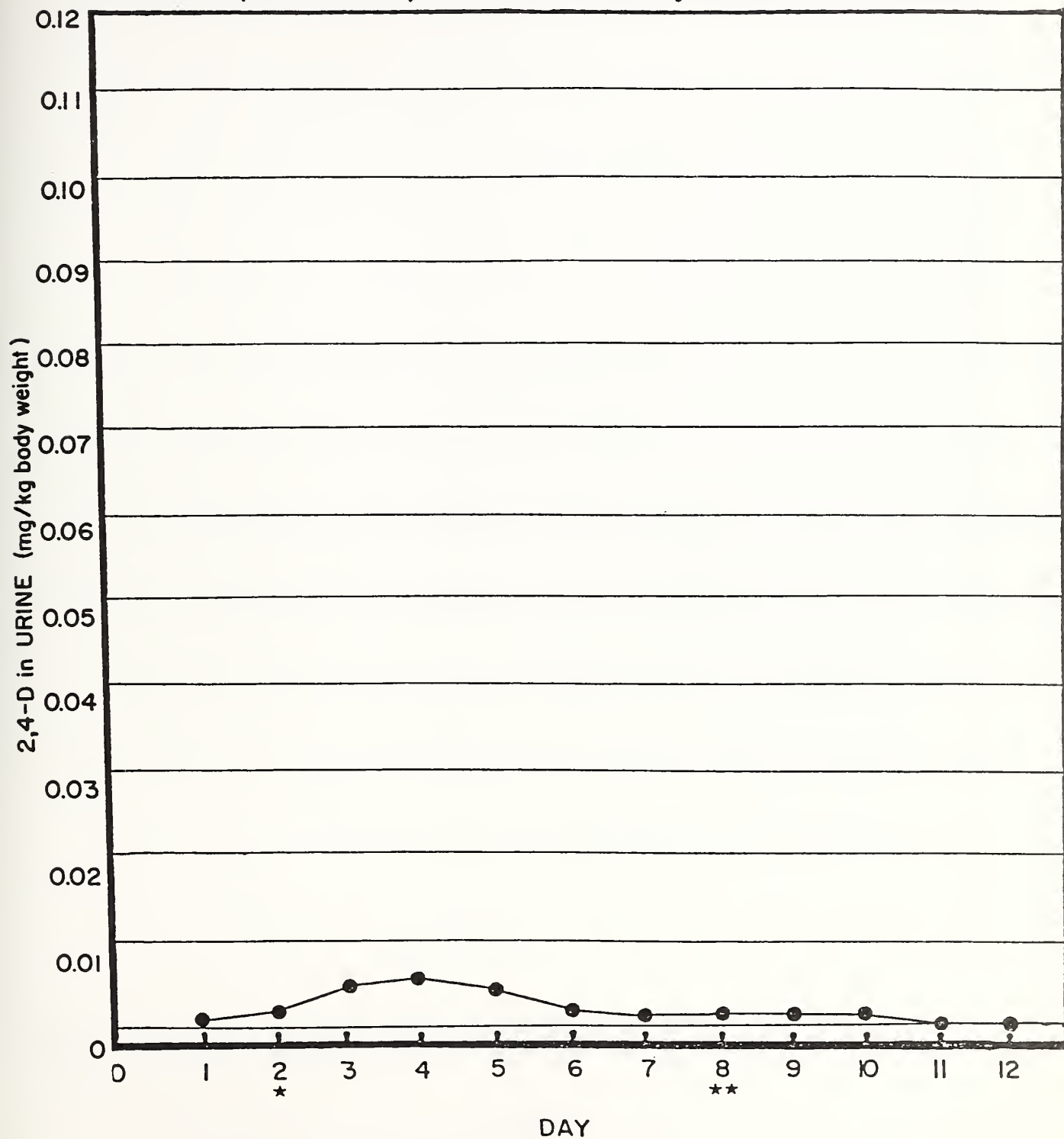


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

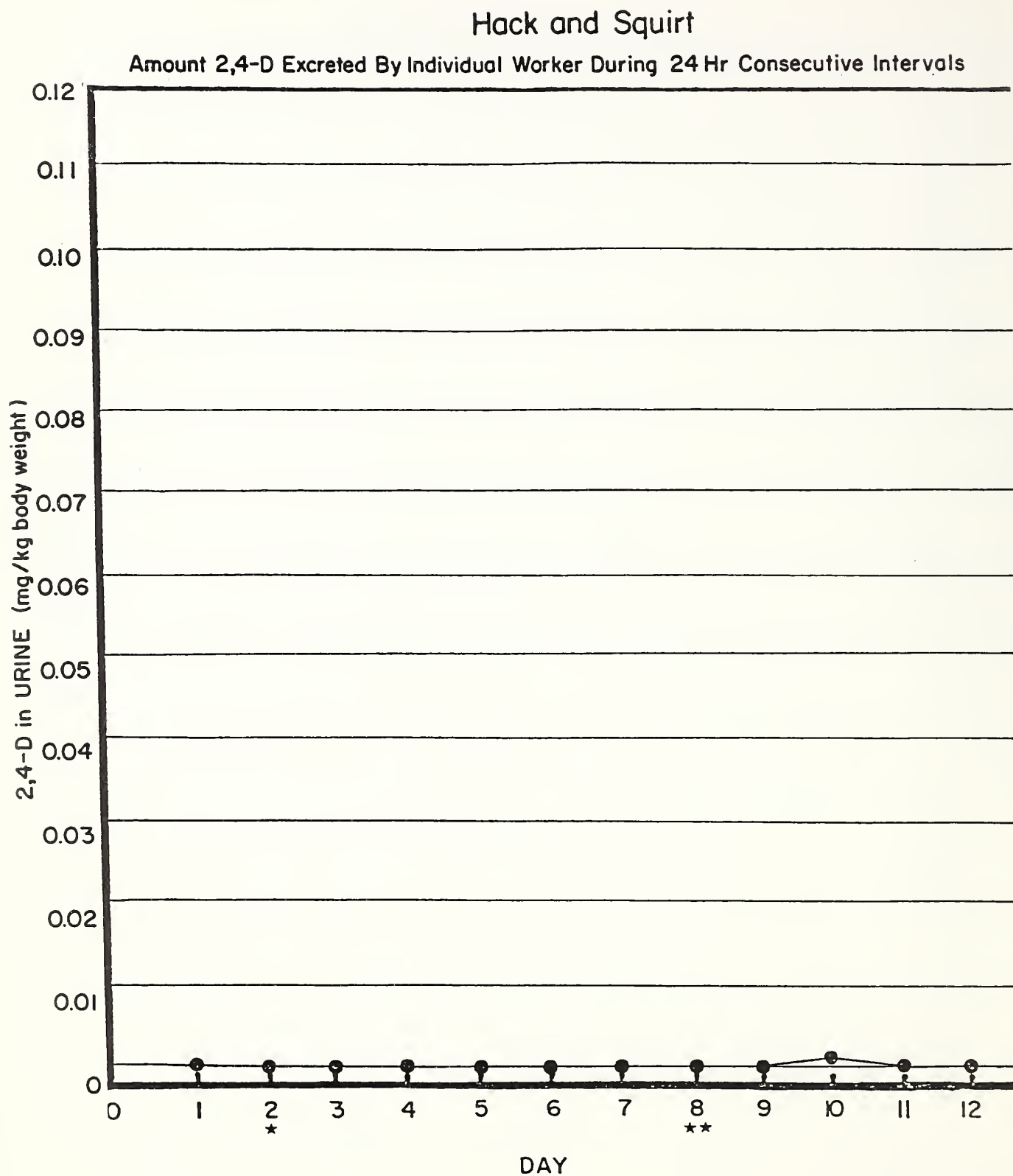
## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

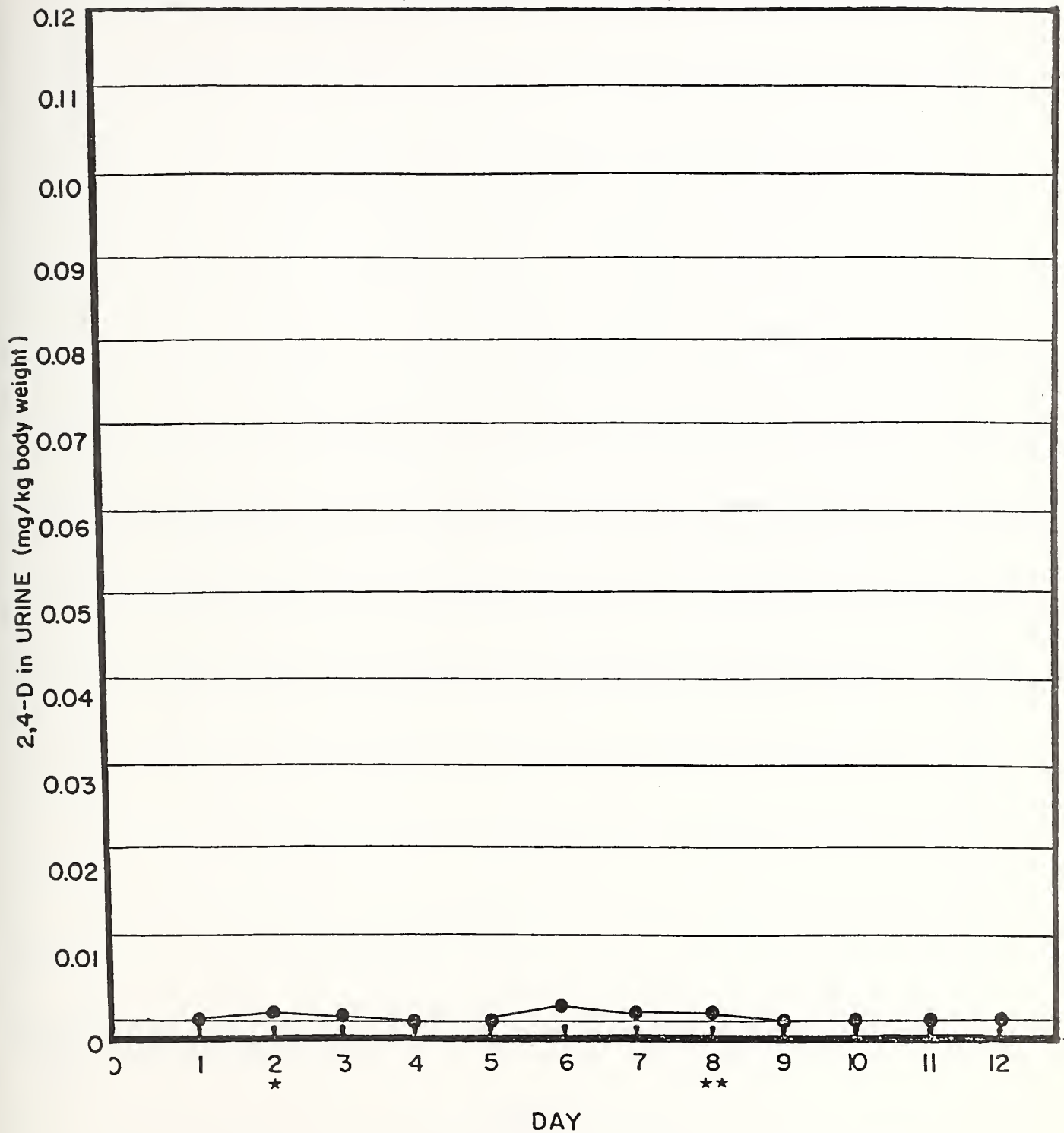


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



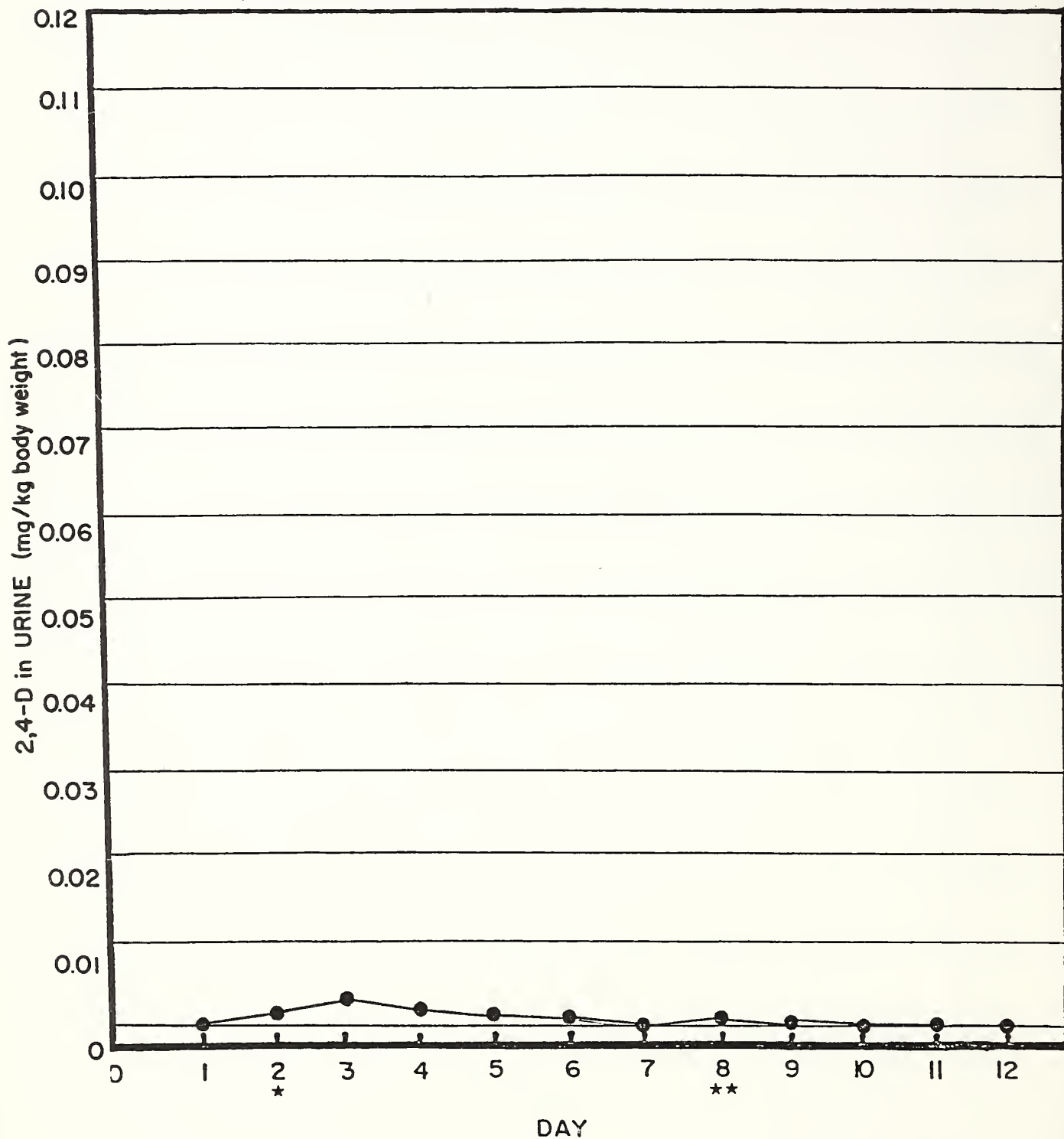
\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed



## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

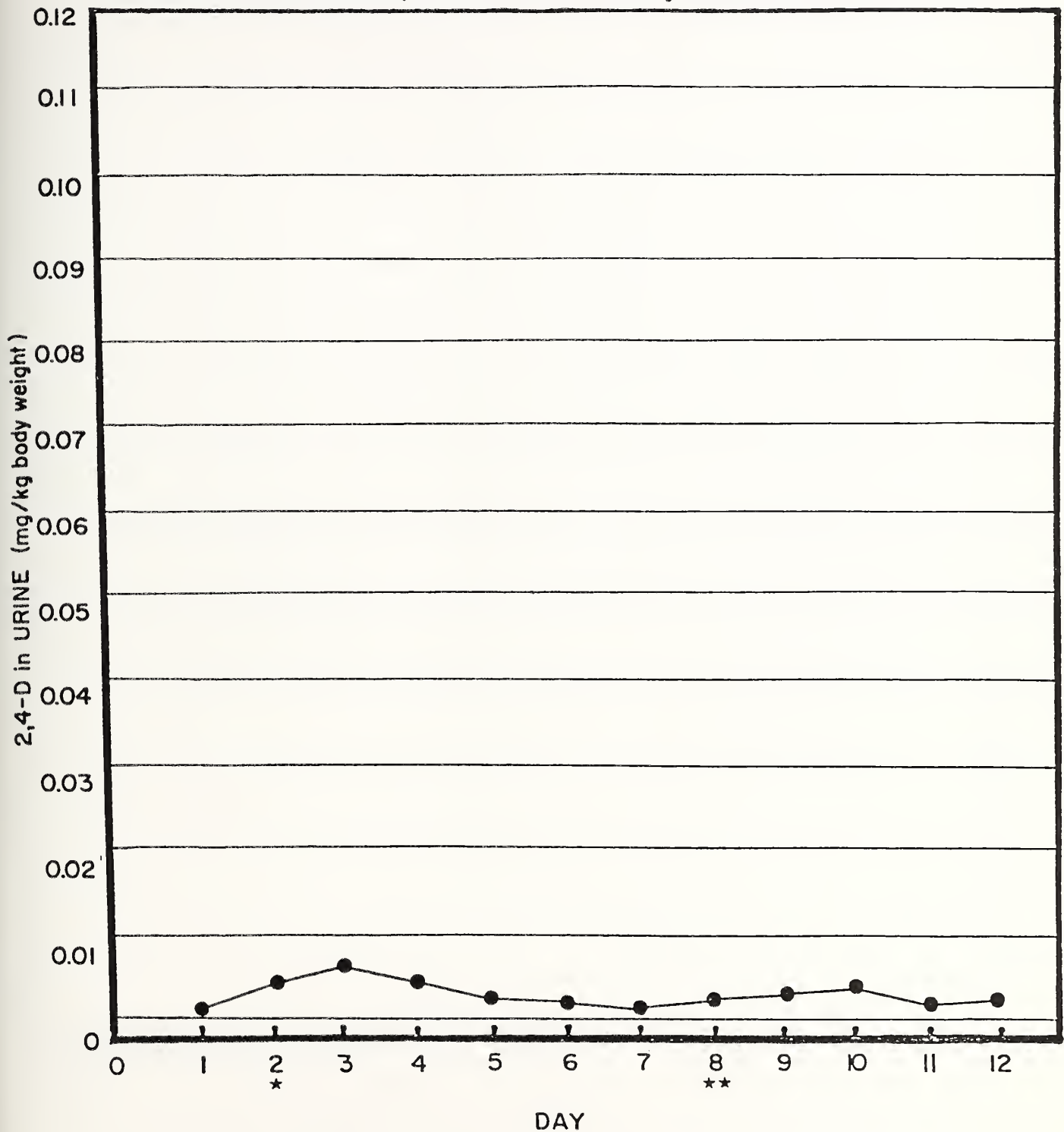


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

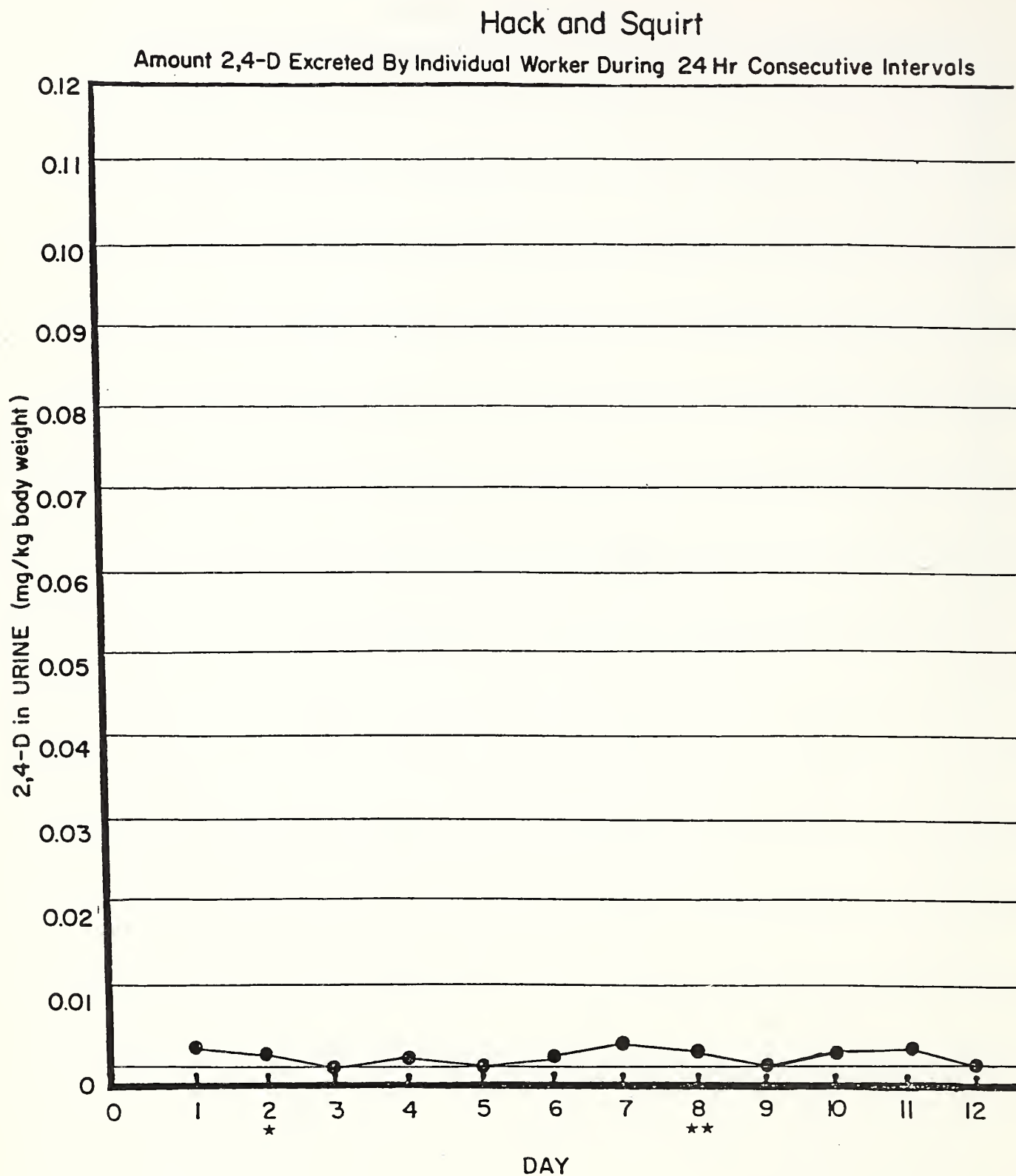
## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

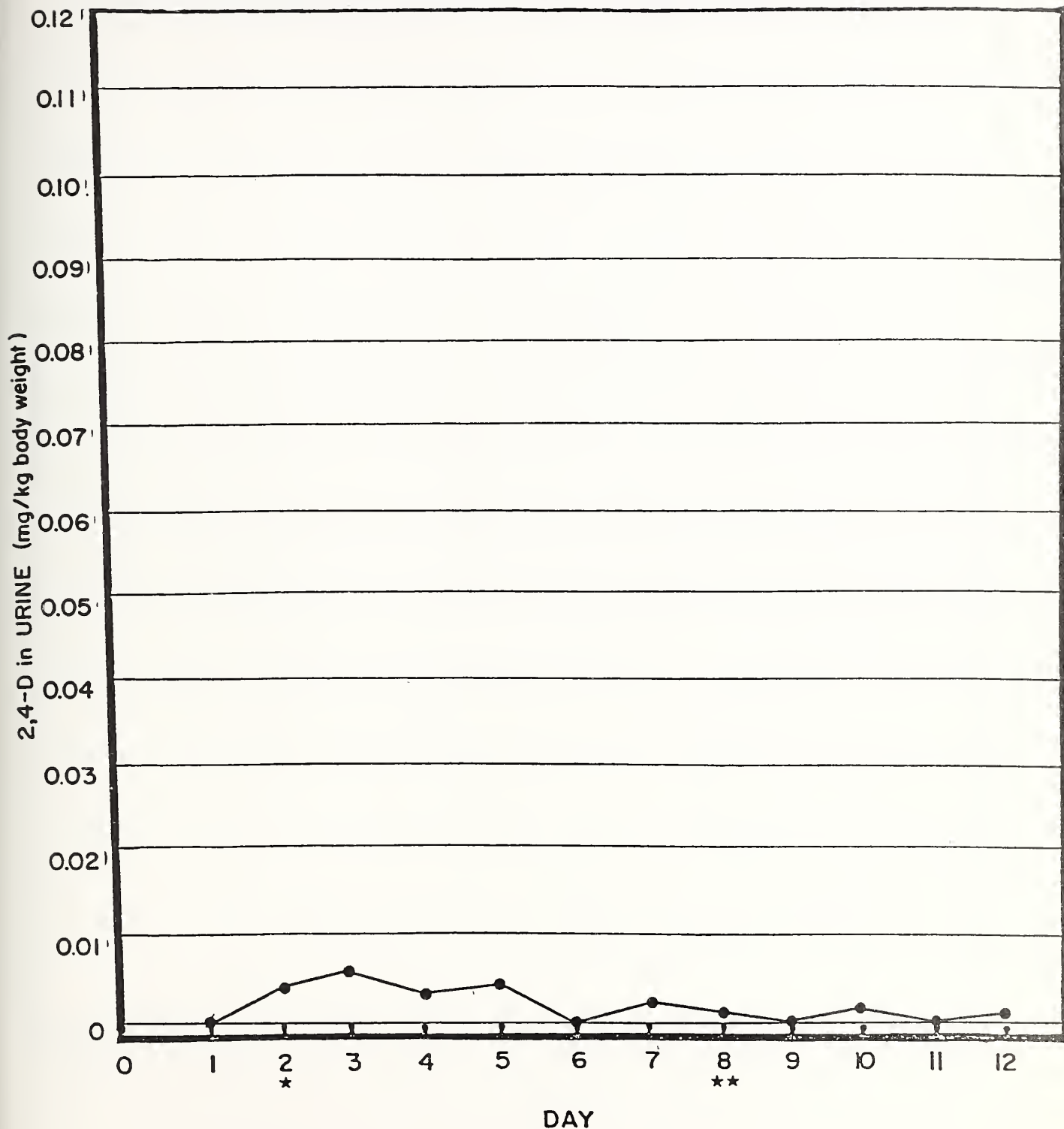


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

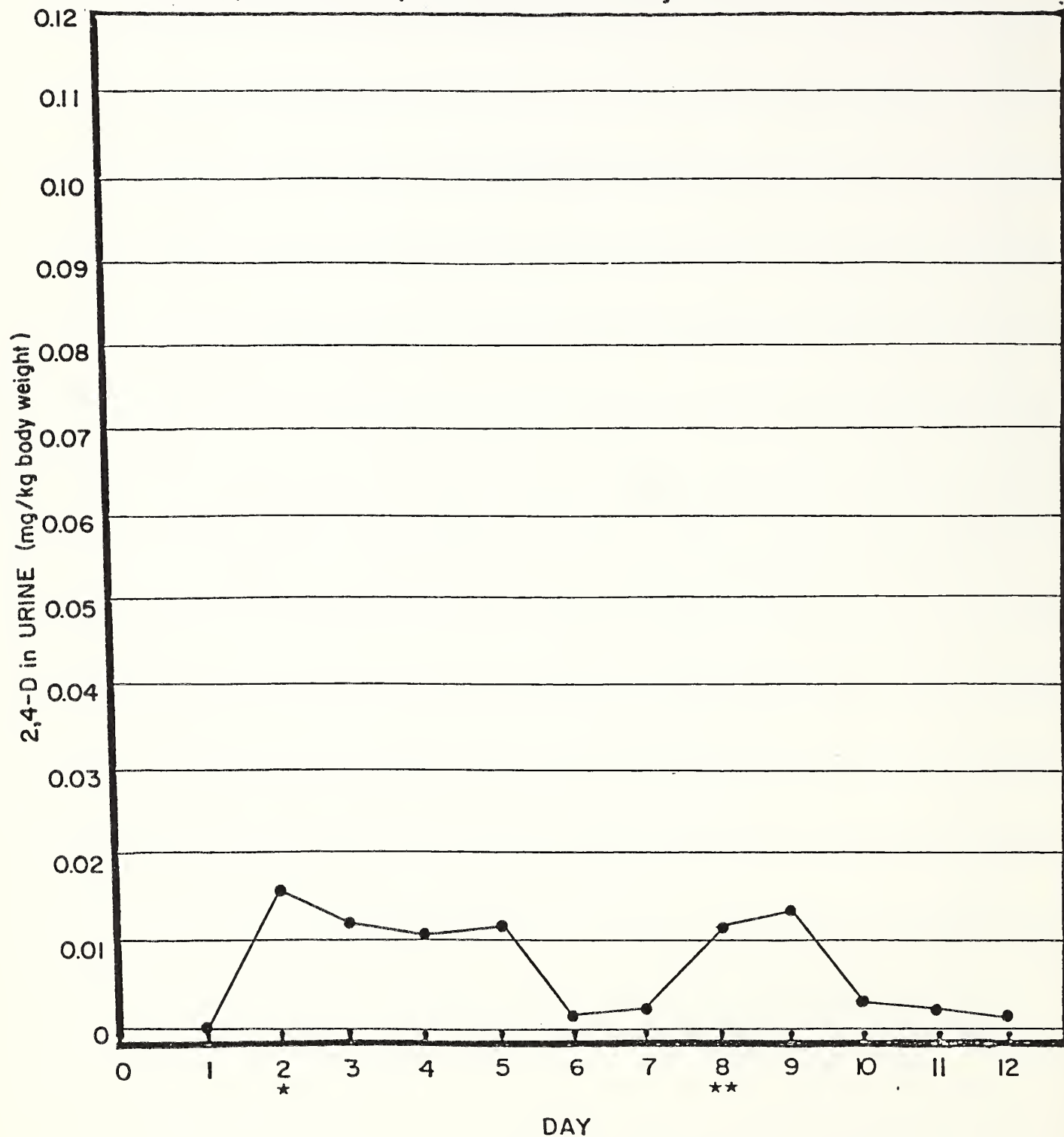


★ Treatment 1 - Ordinary precautions observed

★★ Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

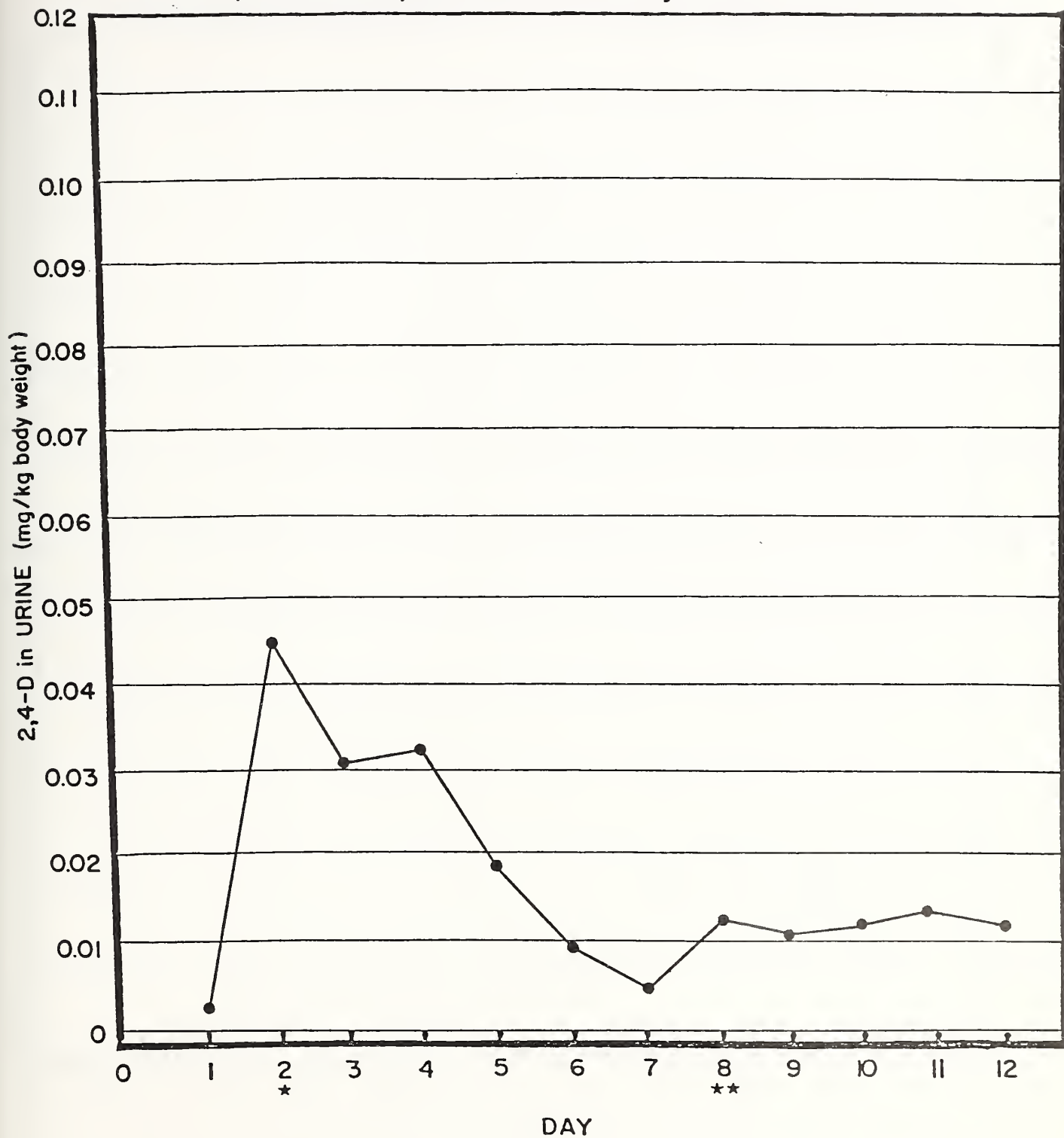


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

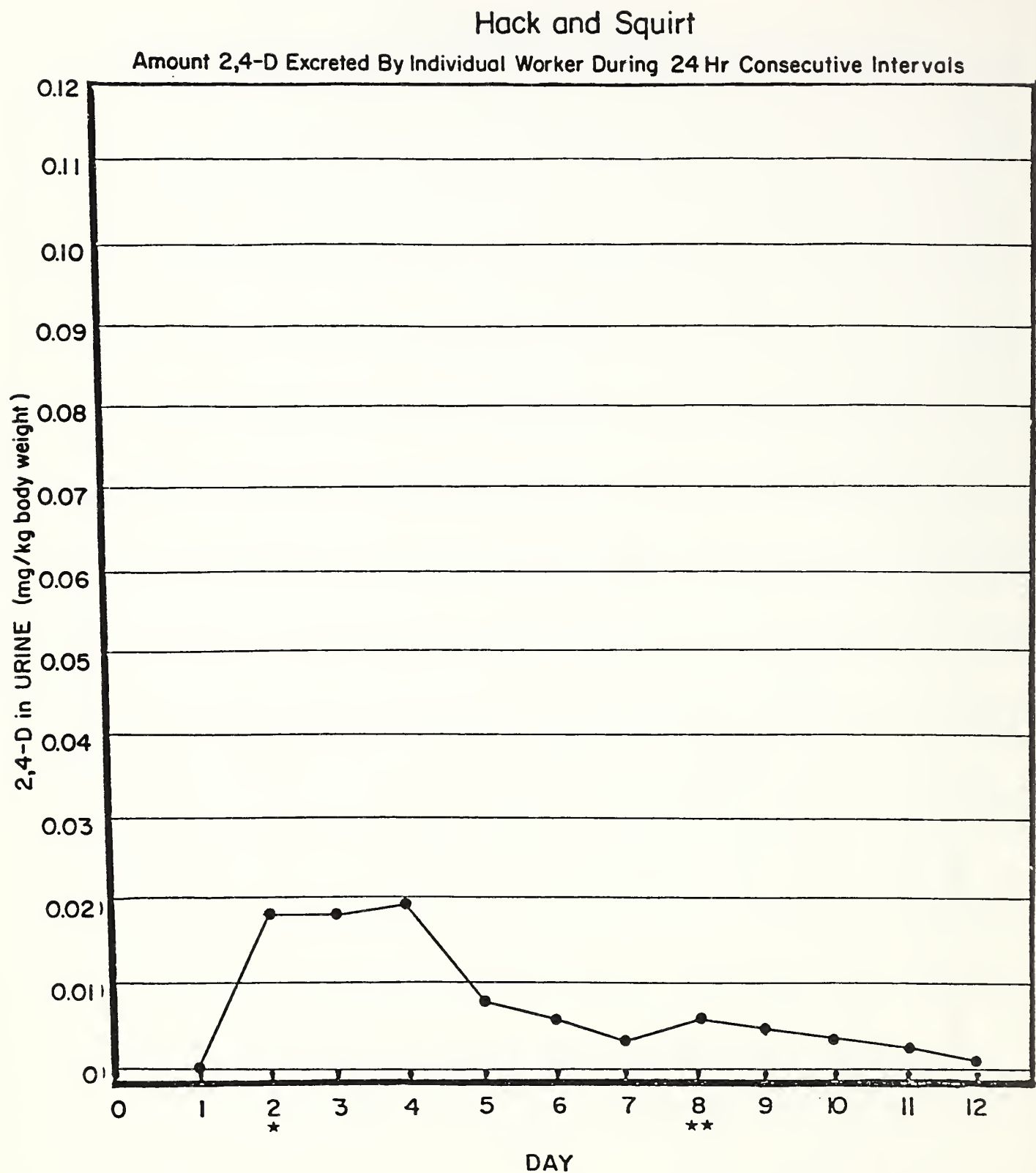
Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



★ Treatment 1 - Ordinary precautions observed

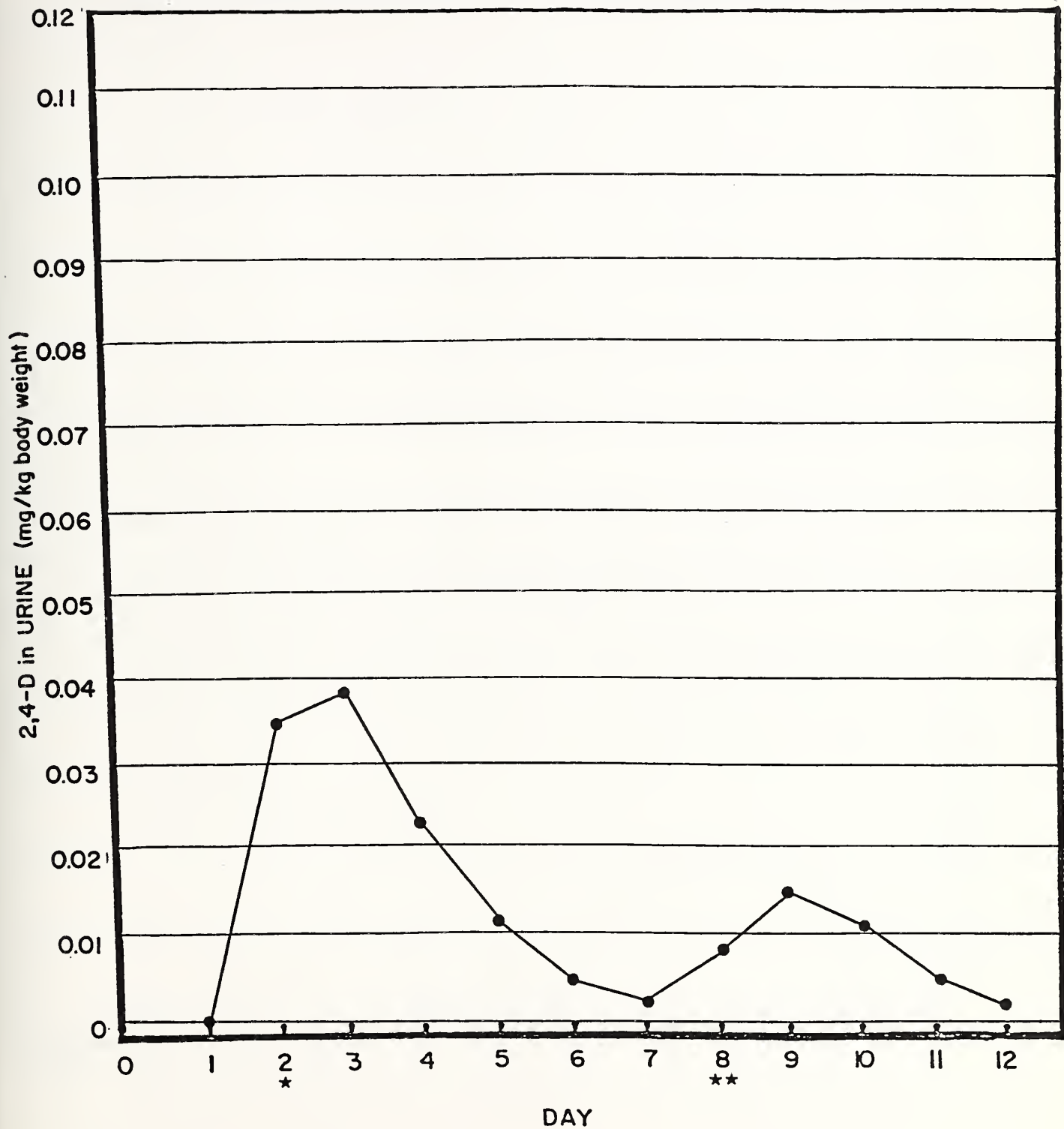
★★ Treatment 2 - Special precautions observed





## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals

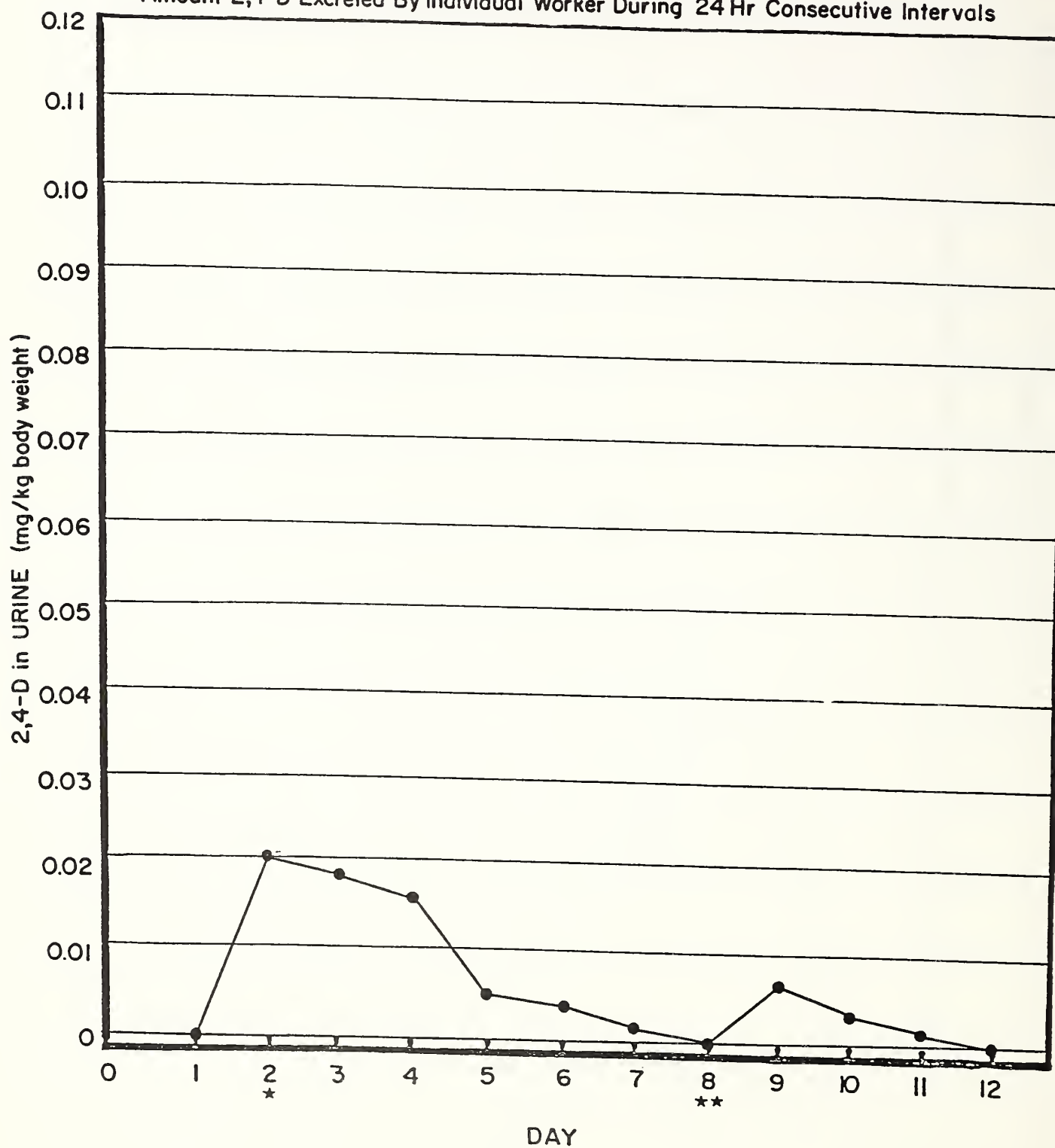


\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

## Hack and Squirt

Amount 2,4-D Excreted By Individual Worker During 24 Hr Consecutive Intervals



\* Treatment 1 - Ordinary precautions observed

\*\* Treatment 2 - Special precautions observed

applied dichlorprop. The excretion rates and the quantity excreted are strikingly similar for the two phenoxy compounds. Prior to this study no information on dichlorprop excretion from humans was available.

Absorbed dose comparisons for backpack sprayers during T<sub>1</sub> and T<sub>2</sub> showed little differences. The new gloves and boots issued to crewmembers during T<sub>2</sub> was not shown to reduce applicator exposure. This probably indicates that spray mist contacting the skin and saturating the clothing is a more important exposure source than herbicide contaminated clothing for the backpack applicators. Field observations revealed that at the end of the spray period the clothing of the backpack crewmembers was soaked with dew, perspiration, and/or spray.

For the backpack application crews, habits or application techniques of individual workers appeared to be somewhat constant during the T<sub>1</sub> and T<sub>2</sub> applications. As an example, workers 1, 5, 6, 7, 10, and 11 maintained minimal exposure during both applications whereas others in their crew absorbed considerably higher amounts during both T<sub>1</sub> and T<sub>2</sub>.

#### Injection Bar Crew Exposure:

This group of 20 workers using the injection bar appears to be one of the least exposed. Two of the individuals provided urine samples with non-detectable herbicide levels for the duration of the T<sub>2</sub> portion of the study. Comparing Table 24, backpack crew, with Table 25, injection bar crew, reveals that during T<sub>1</sub> the backpack crew received 9.2 times as much exposure and that during T<sub>2</sub> on the average they

received 22.9 times more exposure than the injection bar crew. The new leather gloves and boots used during T<sub>2</sub> along with instructions to limit exposure wherever possible appeared to be beneficial since the exposure level for this group during T<sub>2</sub> was significantly less than during T<sub>1</sub>. Since the injection bar routinely strikes the tree at a height somewhere between the knee and the ankles any splash which may occur will probably contact a well-clothed skin area.

#### Hypohatchet Crew Exposure:

The exposure levels received by these crewmembers was intermediate to high as compared to the previously discussed methods. Considerable variability between one applicator and another was not uncommon. A range of 22.8 occurred between the least and the most exposed individual in the group. Of the crews applying the Tordon 101-R® the highest exposure occurred when the hypohatchet was the application tool. More discussion regarding hypohatchet crewmember exposure occurs in the section describing "Notable Items."

#### Hack and Squirt Crew Exposure:

This method of application is not routinely used in forestry management, but was evaluated for comparative purposes. At the 95% confidence level this group of 20 workers and the injection bar crew received less exposure than the groups using the other application methods. As in all groups, variation from worker to worker occurs. One worker in this group had no detectable 2,4-D in any of the 12 urine samples collected. Overall, the number of non-detectable levels of 2,4-D in urine from this group was even greater than that of the injection bar group.

### Notable Items:

Information describing the absorbed dose of 2,4-D for workers using the hypohatchet and hack and squirt application techniques (Tables 26 and 27) are divided into different sections due to the composition of the crews and the differential dose observed in both cases. The first 15 crewmembers (workers 1-15) listed were employed by the USDA Forest Service, whereas, the last 5 (workers 16-20) in each of the two studies, were employed by a commercial herbicide application company.

The delayed and somewhat erratic excretion pattern exhibited by backpack worker 14 (Figure 23) following the T<sub>2</sub> application strongly suggested some type of re-exposure following the prescribed application day. An interview with the worker revealed that approximately 1 week following the T<sub>2</sub> application he had been hospitalized with hepatitis. The unusual excretion pattern probably reflects that he had an abnormally functioning renal system.

An irregularity in the hypohatchet crew occurred when the first seven crewmembers C1-C7 indicated they had been applying the Tordon 101-R® herbicide before the originally scheduled T<sub>1</sub> application. Since the protocol indicated that all workers should avoid 2,4-D exposure for at least 1 week before the test was initiated, the hypohatchet exposure study was delayed a week. As shown in Table 26 and Figures 50-56, this group of seven workers still had slightly elevated levels of 2,4-D in their urine the day before the T<sub>1</sub> test.

The absorbed 2,4-D doses for these seven workers were 2.3 times higher than those of the remainder of the hypohatchet crew (workers



8-15) during the T<sub>1</sub> application. During the T<sub>2</sub> application the comparison for the similarly divided crew showed that workers 1-7 had an absorbed dose of only 60% that of workers 8-15. These data along with the elevated background levels of the 1-7 group strongly suggested that herbicide contaminated clothing (boots, gloves, etc.) was contributing to the high absorbed dose of these seven workers during T<sub>1</sub>. Possibly herbicide residues remained from applications made 8 to 12 days prior to initiating the T<sub>1</sub> portion of the study. All other participants in these studies were applying herbicide for the first time in the season in the T<sub>1</sub> application. One requirement for the T<sub>2</sub> application was that all crewmembers wash their clothing prior to the T<sub>2</sub> application in an attempt to prevent previously contaminated clothing from adding to the absorbed dose which occurred during T<sub>2</sub> application. Another major source of exposure for this crew (Appendix III) reveals that many of the hypohatchet crewmembers reported spilling concentrate on themselves during the T<sub>1</sub> and T<sub>2</sub> phases. Workers C5 and C7 reported that during T<sub>1</sub> tubes to their chemical reservoirs came off allowing the concentrate to soak their trousers.

Post-study interviews of the C1-C7 workers revealed that each crewmember changes his shirt, trousers, and underclothes immediately after each day's work. Some wore gloves and some did not. During the application season none routinely changed gloves or footwear while engaged in field work. Some indicated that a blue color penetrates their boots if they get wet following the time they apply the chemical. The Tordon 101-R® concentrate has a deep blue color. All workers reported getting the concentrate on their hands or leather

gloves (if worn). For these seven workers no differences in the amount of 2,4-D excreted were noted between workers wearing gloves and those who did not.

These interviews in conjunction with the excretion results provide further support for the argument that new leather gloves and new boots, which were a part of the T<sub>2</sub> test, were effective in reducing exposure. These studies have shown that some exposure occurs on the application day and low level exposure from contaminated boots or gloves may occur following the exposure day.

Comparing worker observations made in the field for hypohatchet applicators C-18 and C-19 during the T<sub>1</sub> and T<sub>2</sub> applications suggests that wearing rubber gloves during T<sub>2</sub> was responsible for a marked decrease in exposure (Appendix III and Figures 67 and 68).

Worker D-17 reported using phenoxy herbicide 3 weeks prior to T<sub>1</sub>. He was the only one of the five individuals in his subgroup to have detection levels of 2,4-D in the pre-study urine sample.

The absorbed doses for the five non-Forest Service crewmembers in the hypohatchet and hack and squirt components of the study were significantly higher (5.5 and 12.7 times, respectively) than those of their Forest Service counterparts (Tables 26 and 27; Figures 65-69 and 85-89). Detailed field observation notes (Appendix III) indicated that during their hack and squirt applications faulty squirt devices may have contributed to their higher doses. During hack and squirt application these workers, D16-20, reported that their squirt bottles leaked, allowing concentrate to get on their hands and trousers. These commercial applicators applied somewhat more herbicide per man

and per hour than did their Forest Service counterparts (see Table 7).

No noticeable differences in worker exposure due to weather or location of treatment site were evident for any of the application methods. Only the backpack crew applied herbicide by spraying.

#### Comparisons Among Herbicides:

Tables 28 through 30 reveal very low levels of picloram in urine of workers when compared to dichlorprop and 2,4-D. Picloram and dichlorprop were never present in the same herbicide mixture; however 2,4-D was present with each of the other two herbicides. Figures 90-94 compare the average amounts of dichlorprop, 2,4-D, and picloram excreted in the urine of forest applicators. Figure 91 shows the excretion levels of 2,4-D and dichlorprop are nearly the same. Feldman and Maibach (1974) showed that approximately 6% of dermally applied 2,4-D will penetrate human skin. Since Weedone 170® contains equal amounts of 2,4-D and dichlorprop, and the data in Figure 91 indicate that approximately 6% of the dichlorprop that contacts human skin is absorbed and consequently excreted in urine.

The low amounts of picloram found in urine from workers in our study is in agreement with recent findings of Nolan et al., 1984, who found that picloram does not readily penetrate the skin. Only 0.18% of the picloram applied to skin of human volunteers was absorbed and subsequently excreted in their urine. In a controlled laboratory study they showed that over 96% of the absorbed picloram is excreted in urine within 24 hours.

Information presented in Table 31 allows the comparison of the absorbed 2,4-D dose with the other herbicide for each of the 4 crews.

(Text continued page 158)

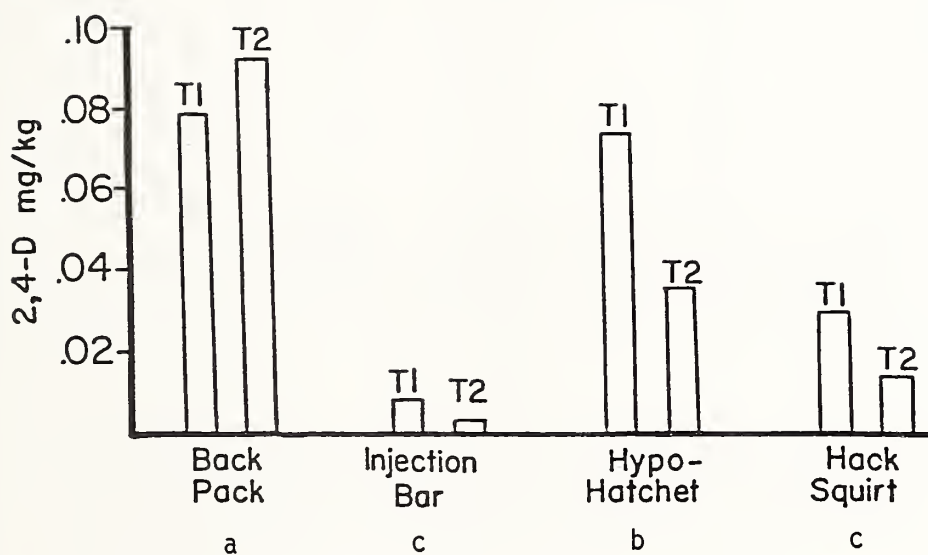


Figure 90. Average amount of 2,4-D excreted in the urine by the four 20-man crews during T<sub>1</sub> and T<sub>2</sub>. Methods with different letters differ significantly at the 0.05 level.

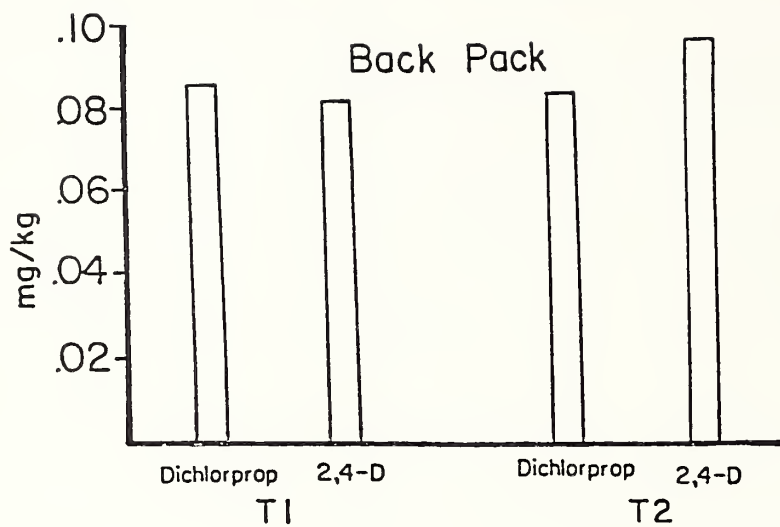


Figure 91. Average amounts of 2,4-D and dichlorprop excreted in the urine of backpack crewmembers during T<sub>1</sub> and T<sub>2</sub>.

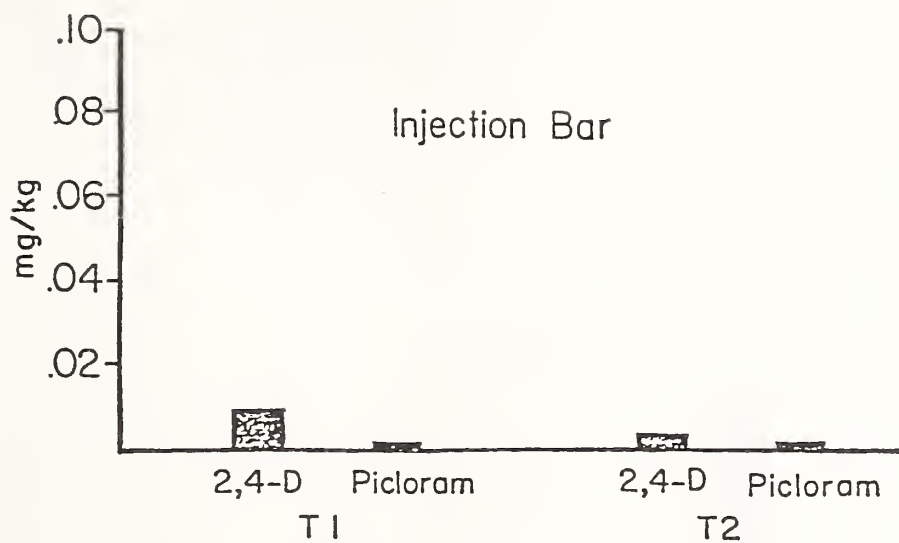


Figure 92. Average amount of 2,4-D and picloram excreted in the urine of injection bar crewmembers during  $T_1$  and  $T_2$ .



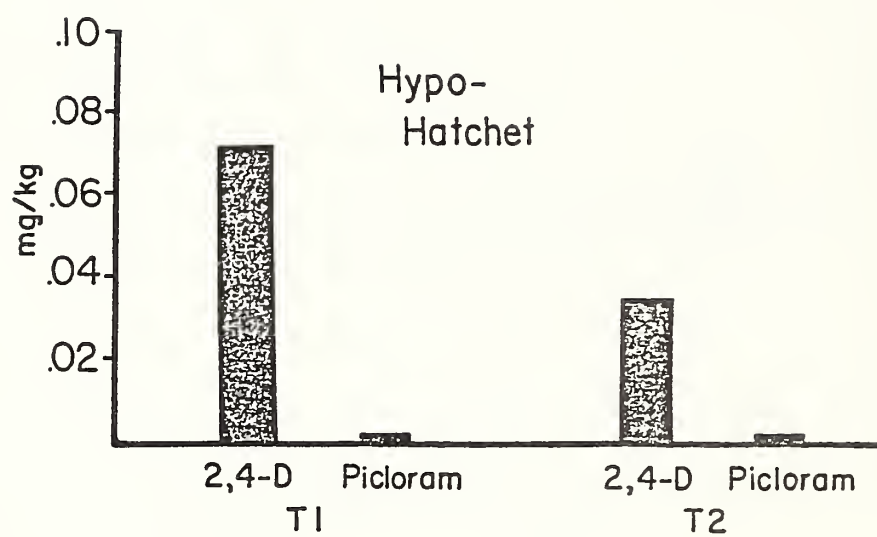


Figure 93. Average amount of 2,4-D and picloram excreted in the urine of hypohatchet crewmembers during T<sub>1</sub> and T<sub>2</sub>.

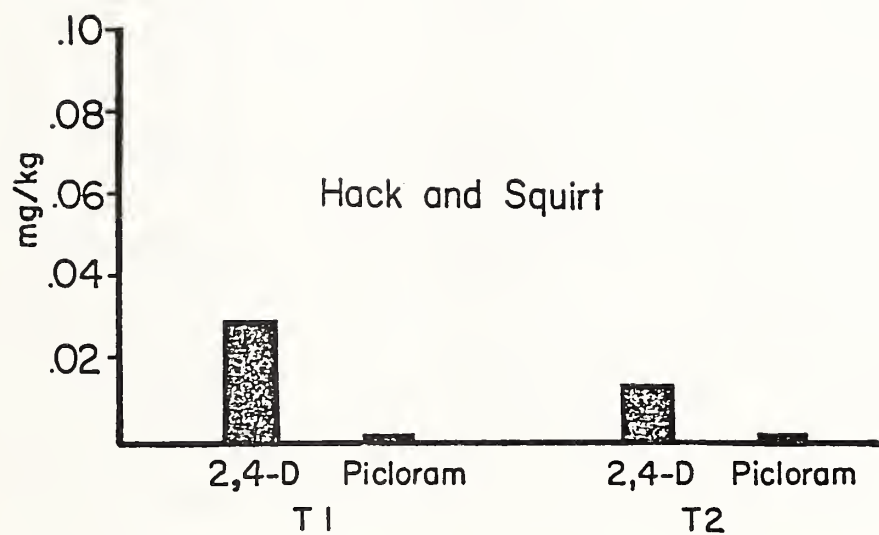


Figure 94. Average amount of 2,4-D and picloram excreted in the urine of hack and squirt crewmembers during T<sub>1</sub> and T<sub>2</sub>.

For most workers the absorbed dose and excretion rates of 2,4-D and dichlorprop were similar. Picloram excretion was more rapid than 2,4-D with the major portion being excreted on the application day.

Table 31. Summary of Dichlorprop, 2,4-D, and Picloram Excretion During T<sub>1</sub> and T<sub>2</sub> for All Crews.

| Method<br>Compound       | Group | T <sub>1</sub>              | T <sub>2</sub> |
|--------------------------|-------|-----------------------------|----------------|
|                          |       | Crew average<br>——(mg/kg)—— |                |
| Backpack<br>dichlorprop  | A     | 0.0855                      | 0.0830         |
| 2,4-D                    |       | 0.0876                      | 0.0980         |
| Injection Bar<br>2,4-D   | B     | 0.0095                      | 0.0043*        |
| Picloram                 |       | 0.000262                    | 0.000053*      |
| Hypohatchet<br>2,4-D     | C     | 0.0848                      | 0.0395*        |
| Picloram                 |       | 0.00217                     | 0.00075*       |
| Hack and Squirt<br>2,4-D | D     | 0.0288                      | 0.0122*        |
| Picloram                 |       | 0.00157                     | 0.000368*      |

\*Significantly different from T<sub>1</sub> at the 0.05 significance level.

Possible routes of body entry as predicted from 2,4-D-picloram ratios.

The Tordon 101-R® concentrate contains 2,4-D and picloram in a ratio of 2,4-D/picloram = 3.7. Using this ratio plus the information that 6% of dermally applied 2,4-D (Feldmann and Maibach, 1974) and 0.18% of dermally applied picloram (Nolan et al., 1984) penetrates the skin, the ratio of 2,4-D to picloram which enters the body as a result of dermal exposure should be  $\frac{6}{.18} \times 3.7 = 123$ . Since 95% or more of both 2,4-D and picloram which enters the body is excreted in the urine within 5 days of exposure, the ratio of the total amount of 2,4-D

excreted during days 2-6 to the total amount of picloram excreted during days 2-6 should be close to 123 if the only entry into the body is through the skin. Of the 60 workers applying Tordon 101-R®, there were 41 instances where detectable amounts of both 2,4-D and picloram were excreted during days 2-6 or 8-12. In 39 instances the ratio of 2,4-D excreted to picloram excreted was less than 123 (Table 32).

Of the 41 ratios calculated for these workers 25 were below 50 and the lowest was 3.7. As stated previously, oral feeding studies have shown that both 2,4-D and picloram are almost quantitatively excreted within 5 days of ingestion. If the only source of exposure was due to oral ingestion, the expected ratio of 2,4-D excreted to picloram excreted would be 3.7. Our findings strongly indicate that some exposure was due to oral ingestion. Since entry into the body in this manner results in close to 100% absorption for both 2,4-D and picloram as opposed to an efficiency of 5% absorption for dermal entry for 2,4-D and 0.18% for picloram, very small orally consumed amounts could equal a dermal exposure.

Since conversations with people involved in and familiar with the application methods reveal that some workers chew and smoke tobacco, these habits could be a source of oral ingestion. In the hot summer months herbicide applicators may habitually attempt to wipe perspiration from their face by rubbing their contaminated shirt cuffs across their face. (One worker said this occurred and that he noticed a bitter taste.) Volunteers in Nolan's study (1984) reported that picloram had a bitter taste. It was also reported that hypohatchet crewmembers would sometimes clear temporarily plugged hatchets by

sucking or blowing on the line and spitting out any concentrate they got in their mouths.

Another possible explanation for most of the ratios being lower than that expected from dermal exposure alone is that the 6% and 0.18% values for penetration of the skin for 2,4-D and picloram are wrong. However, even if that was the case, it would not explain the wide range of ratios from 3.7 to 161.8.

Another possible explanation for ratios being lower than 123 and also quite variable is that the effectiveness of the skin as a barrier to these two compounds may vary greatly from person to person.

Table 32. The Ratio of the Amount of 2,4-D Excreted in the Urine to the Amount of Picloram Excreted in the Urine.

| Worker<br>No. | T <sub>1</sub>   |                  |                   | T <sub>2</sub>   |                  |                   |
|---------------|------------------|------------------|-------------------|------------------|------------------|-------------------|
|               | 2,4-D            | Picloram         | Ratio             | 2,4-D            | Picloram         | Ratio             |
|               | ug<br>kg body wt | ug<br>kg body wt | 2,4-D<br>picloram | ug<br>kg body wt | ug<br>kg body wt | 2,4-D<br>picloram |
| B-1           | 11.8             | 0.451            | 26.1              |                  |                  |                   |
| B-4           | 3.6              | 0.024            | 150.0             |                  |                  |                   |
| B-8           | 6.6              | 0.816            | 8.1               |                  |                  |                   |
| B-10          | 23.4             | 1.26             | 18.6              | 8.0              | 0.767            | 10.4              |
| B-12          | 16.4             | 1.83             | 9.0               |                  |                  |                   |
| B-13          | 17.1             | 0.857            | 20.0              | 12.1             | 0.297            | 40.7              |
| C-1           | 37.0             | 0.521            | 71.0              |                  |                  |                   |
| C-2           | 132.4            | 1.67             | 79.3              |                  |                  |                   |
| C-5           | 196.4            | 2.16             | 90.9              |                  |                  |                   |
| C-6           | 83.1             | 1.44             | 57.7              |                  |                  |                   |
| C-7           | 262.9            | 4.35             | 60.4              | 23.3             | 0.494            | 47.2              |
| C-8           | 27.0             | 2.05             | 13.2              | 56.6             | 0.753            | 75.2              |
| C-9           | 15.1             | 0.855            | 17.7              |                  |                  |                   |
| C-12          | 25.4             | 0.157            | 161.8             |                  |                  |                   |
| C-14          | 34.5             | 0.441            | 78.2              |                  |                  |                   |
| C-15          | 19.5             | 0.904            | 21.6              |                  |                  |                   |
| C-16          | 127.2            | 2.28             | 55.8              | 103.5            | 0.92             | 112.5             |
| C-17          | 52.9             | 14.23            | 3.7               | 39.6             | 8.18             | 4.8               |
| C-18          | 91.7             | 1.61             | 57.0              |                  |                  |                   |
| C-20          | 63.0             | 2.01             | 31.3              | 54.7             | 2.14             | 25.6              |
| D-4           | 31.0             | 2.80             | 11.1              | 19.2             | 0.37             | 51.9              |
| D-13          | 16.9             | 0.86             | 19.7              | 11.9             | 0.731            | 16.3              |
| D-15          | 16.1             | 2.06             | 7.8               |                  |                  |                   |
| D-16          | 52.3             | 1.89             | 27.7              | 33.7             | 0.846            | 39.8              |
| D-17          | 140.8            | 2.07             | 68.0              | 60.3             | 0.764            | 78.9              |
| D-18          | 70.9             | 7.32             | 9.7               | 18.1             | 1.27             | 14.3              |
| D-19          | 112.8            | 12.3             | 9.2               | 42.9             | 1.52             | 28.2              |
| D-20          | 64.5             | 0.629            | 102.5             |                  |                  |                   |

#### T<sub>1</sub> versus T<sub>2</sub> exposure:

A significant reduction in exposure to both 2,4-D and picloram in T<sub>2</sub> as compared to T<sub>1</sub> was shown in comparing the absorbed dose of workers participating in the injection bar, hypohatchet, and hack and squirt application (Table 31). An LSD<sub>.05</sub> of 0.0209 mg/kg was found for 2,4-D among application methods. These data in Table 31 indicate the combination of new boots and gloves and other precautionary measures



employed in T<sub>2</sub> were effective in limiting the absorbed dose of 2,4-D to forest workers applying this compound in combination with picloram when the injection bar, hypohatchet, or hack and squirt application methods were employed. New boots and gloves did not reduce the absorbed dose levels for the backpack crewmembers.

#### Significance of absorbed doses.

The margin of safety is the ratio of the no observed effect level (NOEL) to the exposure level: 
$$\text{i.e. } \frac{\text{NOEL}}{\text{exposure level (absorbed dose)}}.$$

This is a useful means of evaluating the toxicological significance of the exposure measured in this study.

The average margin of safety for crews employing different application methods during T<sub>1</sub> and T<sub>2</sub> are shown in Table 33.

Table 33. Average Margin of Safety.

|                 | Dichlorprop    |                | 2,4-D <sup>b</sup> |                | Picloram <sup>c</sup> |                |
|-----------------|----------------|----------------|--------------------|----------------|-----------------------|----------------|
|                 | T <sub>1</sub> | T <sub>2</sub> | T <sub>1</sub>     | T <sub>2</sub> | T <sub>1</sub>        | T <sub>2</sub> |
| Backpack        | 281            | 289            | 274                | 245            |                       |                |
| Injection bar   |                |                | 2,526              | 5,581          | 190,800               | 943,400        |
| Hypohatchet     |                |                | 283                | 607            | 23,000                | 66,700         |
| Hack and squirt |                |                | 833                | 1,967          | 31,800                | 135,900        |

$$^a\text{A Margin of Safety} = \frac{\text{NOEL mg/kg/day}}{\text{Absorbed Dose mg/kg/application}}$$

<sup>b</sup>Using 24 mg/kg as the NOEL as developed by the 2,4-D Scientific Advisory Panel.

<sup>c</sup>Using 50 mg/kg as the NOEL (National Research Council Canada)(Hall, 1980).

The most highly exposed person in this study was worker A 18 during T<sub>2</sub> (see Tables 23 and 24). His absorbed dose of dichlorprop for the 5 days during T<sub>2</sub> was 0.1783 mg/kg. During this 5-day period

his absorbed dose of 2,4-D was 0.2445 mg/kg. If these numbers are divided into a NOEL of 24 mg/kg/day as established for 2,4-D by the 2,4-D Scientific Advisory Team, safety factors of 98 and 134, respectively result for 2,4-D and dichlorprop. In other words this worker would have had to receive an absorbed dose of 2,4-D which was 98 times higher than he received to be at the NOEL. (It should be noted that the NOEL is based on long-term feeding studies where the subjects (rats) are fed this dose every day.)

Summary:

Comparing only the methods of application, exposure of backpack crewmembers was higher than hypohatchet which, was higher than injection bar and hack and squirt (Figure 90).

In comparing the amounts of herbicide excreted, Figure 91 shows that similar amounts of 2,4-D and dichlorprop were excreted. In Figures 92, 93, and 94 levels of 2,4-D excretion are shown to be much higher than picloram excretion for all of the crews applying Tordon 101-R®. Protective clothing and procedures used in this study were not shown to reduce exposure for the backpack application method; however, they did reduce exposure to 2,4-D when application was done by injection bar, hack and squirt, and hypohatchet.

Workers C16-20, and D16-20 received significantly more exposure than workers C1-15 and D1-15, respectively. The absorbed 2,4-D dose for workers 16-20 in group C was comparable to the amounts received by workers in the backpack crew (Group A). However, using data in Table 2, it can be shown that the 2,4-D concentration used by workers in groups B, C, and D was approximately 13 times greater than that used

by the backpack crewmembers. Thus, a proportionally smaller amount of the liquid concentrate contacting the skin would presumably be required to provide a similar absorbed dose. Therefore, protection that provided only a small decrease in the amount of concentrate contacting the skin would result in a large decrease in absorbed dose.

Results of these studies have shown that even those workers who spilled concentrate on themselves still had large margins of safety. As a group the backpack workers received the highest absorbed dose and had the lowest margin of safety for 2,4-D. These data in conjunction with data on NOEL indicate that this group could have received 280 times greater exposure and still not have attained health threatening levels. Margins of safety for picloram are considerably higher since a smaller absorbed dose was shown and the NOEL for this herbicide is higher.

#### Concluding Remarks:

As shown in Appendix III several crewmembers reported coming into contact with the concentrate. As a general rule, the workers' field observations of exposure were of value in assaying the anticipated absorbed dose. However, it appears from Figures 10-89 that a worker's perception of the amount of concentrate contacting his skin varies greatly from one worker to another since some who reported considerable contact exhibited a small absorbed dose. (See Figures 73 and 74, and Appendix III.)

When assessing the overall exposure of 80 forest workers applying herbicides it becomes apparent that the work habits, luck etc. for some individuals, as measured by urinary excretion of herbicides, vary

markedly between individuals. In some cases field notes clearly show that "hose broke on bottle" (worker C-5) allowing concentrate to get on the worker. It appears that if provisions could be made to quickly remove the concentrate from the skin the absorbed dose could be significantly decreased. A few "incidents" or "unlucky" workers raise the average exposure level markedly. Although as shown in Table 33 all groups and individuals possess large margins of safety it appears possible to limit exposure even more.

Overall Findings:

- 1) most forest herbicide applicators receive an absorbed dose.
- 2) equal excretion rates and amounts were observed for 2,4-D and dichlorprop in the urine of exposed workers.
- 3) the absorbed dose of picloram is much lower than that of 2,4-D.
- 4) by employing precautionary measures the absorbed dose can be reduced.
- 5) backpack sprayers appeared to receive the highest dose and those using injection bar and hack and squirt applicators receive the lowest dose.
- 6) none of the workers received an absorbed dose approaching health threatening levels.

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## Appendices

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# Appendix I. Daily Creatinine Excretion for All Workers

| Worker # | Mg of Creatinine excreted per day <sup>a</sup> |      |      |      |      |      |      |      |      |      |      |      |
|----------|--|------|------|------|------|------|------|------|------|------|------|------|
|          | Day #  |      |      |      |      |      |      |      |      |      |      |      |
|          | 1  | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
| A-1      | 2.11   | 2.17 | 2.02 | 2.14 | 1.54 | 2.13 | 1.86 | 2.30 | 2.19 | 1.99 | 1.29 | 2.32 |
| 2        | 1.85   | 2.14 | 2.18 | 1.64 | 2.69 | 2.40 | 1.69 |      | b    | 2.38 | 2.68 | 2.59 |
| 3        | 1.29   | 1.58 | 0.98 | 1.68 | 1.74 | 1.51 | 2.85 |      | b    | 1.56 | 1.11 | 1.51 |
| 4        | 1.99   | 1.66 | 2.74 | 2.54 | 2.34 | 1.88 | 2.34 | 2.80 | 2.60 | 2.59 | 2.90 | 2.49 |
| 5        | 1.93   | 1.70 | 1.64 | 1.44 | 1.82 | 1.57 | 1.69 | 1.67 | 1.90 | 1.84 | 2.04 | 1.91 |
| 6        | 2.06   | 1.21 | 1.76 | 1.19 | 2.22 | 1.51 | 1.58 | 1.64 | 2.06 | 0.86 | 1.68 | 1.31 |
| 7        | 2.50   | 2.31 | 1.69 | 0.20 | 2.20 | 1.72 | 2.40 | 2.40 | 3.02 |      | b    | 2.44 |
| 8        | 1.76   | 1.84 | 1.49 | 1.32 | 1.66 | 1.35 | 1.57 | 1.38 | 1.82 | 1.52 | 1.90 | 1.53 |
| 9        | 2.17   | 2.13 | 1.71 | 1.59 | 1.77 | 0.04 | 2.13 | 2.13 | 1.57 | 1.81 | 1.15 | 1.61 |
| 10       | 1.18   | 1.37 | 1.04 | 1.09 | 1.30 | 0.93 | 1.83 | 1.26 | 1.98 | 1.73 | 1.71 | 1.84 |
| 11       | 2.30   | 2.42 | 2.16 | 2.51 | 2.64 | 2.31 | 2.32 |      | b    | 3.46 | 2.56 | 0.17 |
| 12       | 1.93   | 1.90 | 2.10 | 1.86 | 2.08 | 1.74 | 2.04 | 1.97 | 1.85 | 1.99 | 1.92 | 2.04 |
| 13       | 2.24   | 1.86 | 1.71 | 1.95 | 2.45 | 1.90 | 2.01 | 2.06 | 2.42 | 1.34 | 1.96 | 1.16 |
| 14       | 2.35   | 1.71 | 2.15 | 2.55 | 2.05 | 2.04 | 2.16 | 2.13 | 2.26 | 2.51 | 2.15 | 2.79 |
| 15       | 2.43   | 2.27 | 2.40 | 2.64 | 3.36 | 2.04 | 2.60 | 2.58 | 2.69 | 2.42 | 2.71 | 2.71 |
| 16       | 1.86   | 2.41 | 2.16 | 2.59 | 2.33 | 2.15 | 2.23 | 2.37 | 2.86 | 2.55 | 2.70 | 1.23 |
| 17       | 2.22   | 2.13 | 2.08 | 2.49 | 2.33 | 1.79 | 2.11 | 2.39 | 2.10 | 2.67 | 2.34 | 1.93 |
| 18       | 1.72   | 1.63 | 1.61 | 1.87 | 1.49 | 1.56 | 1.83 | 1.82 | 2.11 | 1.50 | 2.10 | 1.86 |
| 19       | 1.59   | 2.73 | 2.05 | 2.10 | 1.68 | 2.01 | 1.85 | 1.13 | 2.15 | 2.28 | 2.05 | 2.16 |
| 20       | 2.36   | 2.36 | 2.31 | 2.33 | 3.01 | 1.90 | 2.74 | 2.73 | 2.50 | 2.68 | 2.26 | 3.32 |
| B-1      | 2.34   | 2.54 | 2.49 | 2.65 | 2.50 | 2.78 | 2.50 | 2.46 | 2.87 | 2.44 | 1.10 | 2.43 |
| 2        | 1.48   | 2.00 | 1.77 | 1.71 |      | b    | 1.76 | 1.66 | 1.88 | 1.80 | 1.86 | 1.92 |
| 3        | 2.55   | 4.59 | 4.45 | 2.85 | 2.60 | 2.25 | 3.01 | 2.36 | 2.95 | 3.37 | 2.50 | 3.14 |
| 4        | 2.90   | 3.08 | 1.97 | 2.48 | 3.04 | 3.13 | 2.91 | 3.26 | 3.27 | 3.25 | 2.74 | 3.32 |
| 5        | 1.75   | 1.73 | 1.88 | 1.51 | 1.58 | 1.75 | 1.75 | 1.71 | 1.79 | 1.75 | 1.57 | 1.68 |
| 6        | 1.66   | 1.83 | 1.81 | 1.83 | 1.81 | 1.68 | 1.76 | 1.44 | 1.87 | 1.70 | 1.60 | 1.75 |
| 7        | 2.37   | 1.51 | 2.33 |      | b    | 2.29 | 2.36 | 2.35 | 2.64 | 2.70 | 2.67 | 2.31 |
| 8        | 2.10   | 1.86 | 1.90 | 1.81 | 1.81 | 1.75 | 1.72 | 1.68 | 1.82 | 1.70 | 1.92 | 1.68 |
| 9        | 2.57   | 1.90 | 1.59 | 1.66 | 1.83 | 1.64 | 1.76 | 1.82 | 2.08 | 1.79 | 1.77 | 1.82 |
| 10       | 2.85   | 2.29 | 1.70 | 2.02 | 1.73 | 1.93 | 1.92 | 1.81 | 1.98 | 1.87 | 2.74 | 1.99 |
| 11       | 2.03   | 1.91 | 2.01 | 2.23 | 2.10 | 1.79 | 2.33 | 1.93 | 2.00 | 1.82 | 1.52 | 2.26 |
| 12       | 3.13   | 0.08 | 2.27 | 2.13 | 2.33 | 2.08 | 2.49 | 2.47 | 2.68 | 2.48 | 2.18 | 2.56 |
| 13       | 3.12   | 2.53 | 2.34 | 2.32 | 2.31 | 2.43 | 2.31 | 2.35 |      | b    | 2.43 | 2.21 |
| 14       | 2.32   | 1.93 | 1.91 | 1.71 | 1.77 | 1.81 | 1.79 | 2.08 | 1.80 | 1.97 | 1.79 | 1.77 |
| 15       | 2.54   | 2.14 | 2.04 | 1.92 | 1.79 | 2.19 | 2.02 | 2.09 | 2.13 | 1.81 | 2.09 | 2.02 |
| 16       | 2.01   | 1.86 | 2.17 | 1.70 | 1.87 | 1.98 | 1.84 | 1.80 | 1.41 | 1.81 | 1.66 | 2.07 |
| 17       | 1.92   | 1.86 | 2.36 | 2.03 | 2.23 | 1.91 | 1.83 | 1.92 | 1.73 | 2.23 | 1.95 | 1.87 |
| 18       | 2.70   | 2.49 | 2.66 | 2.90 | 1.98 | 2.44 | 2.71 | 2.65 | 2.56 | 3.20 | 2.73 | 2.70 |
| 19       | 2.61   | 2.06 | 1.87 | 2.11 | 2.02 | 2.14 | 2.11 | 2.14 | 2.10 | 2.29 | 1.84 | 1.92 |
| 20       | 2.09   | 2.23 | 1.83 | 1.17 | 2.10 | 2.11 | 1.95 | 2.21 | 1.91 | 2.20 | 1.50 | 1.90 |

| Mg of Creatinine excreted per day <sup>a</sup> (continued) |       |      |      |      |      |      |      |      |      |      |      |      |
|--|-------|------|------|------|------|------|------|------|------|------|------|------|
| Worker   | Day # |      |      |      |      |      |      |      |      |      |      |      |
| #  | 1     | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
| C-1  | 2.07  | 1.93 | 2.14 | 1.95 | 1.85 | 1.87 | 1.76 | 1.65 | 1.63 | 1.74 | 1.73 | 1.53 |
| 2  | 1.74  | 2.29 | 1.81 | 1.97 | 1.56 | 1.64 | 1.76 | 1.59 | 1.98 | 2.08 | 1.46 | 1.64 |
| 3  | 2.27  | 2.06 | 2.34 | 2.17 | 2.14 | 2.03 | 2.12 | 1.84 | 1.83 | 1.82 | 1.84 | 1.84 |
| 4  | 2.32  | 2.47 | 2.30 | 2.55 | 2.39 | 2.32 | b    | 2.27 | 2.05 | 2.07 | 2.39 | 1.86 |
| 5  | 2.09  | 2.04 | 2.51 | 1.82 | 2.30 | 2.62 |      | 1.89 | 1.85 | 1.87 | 1.78 | 1.63 |
| 6  | 2.76  | 2.85 | 3.10 | 2.62 | 3.16 | 2.42 | 2.61 | 2.55 | 2.40 | 2.67 | 2.28 | 2.29 |
| 7  | 2.22  | 1.98 | 1.88 | 2.06 | 1.72 | 2.18 | 1.96 | 1.67 | 1.70 | 1.80 | 1.81 | 1.76 |
| 8  | 2.66  | 1.89 | 2.01 | 1.87 | 1.89 | 2.01 | 1.90 | 2.00 | 1.86 | 2.04 | 1.95 | 1.79 |
| 9  | 2.15  | 1.92 | 2.05 | 1.81 | 2.11 | 1.76 | 2.00 | 2.53 | 1.98 | 1.96 | 2.28 | 2.13 |
| 10   | 2.93  | 2.31 | 2.20 | 2.48 | 2.19 | 2.15 | 2.41 | 2.40 | 2.45 | 2.41 | 2.33 | 2.44 |
| 11   | 2.02  | 2.16 | 2.07 | 2.16 | 2.14 | 1.79 | 2.04 | 2.19 | 2.24 | 2.34 | 1.96 | 2.30 |
| 12   | b     | 1.66 | 1.87 | 2.07 | 1.57 | 1.65 | 1.78 | 2.22 | 1.72 | 2.00 | 1.77 | 2.36 |
| 13   |       | 2.55 | 1.75 | 1.81 | 1.75 | 2.05 | 1.70 | 1.81 | 2.04 | 2.11 | 1.53 | 2.19 |
| 14   | 2.63  | 2.52 | 2.30 | 2.92 | 2.66 | 1.87 | 2.00 | 2.46 | 2.61 | 2.35 | 2.99 | 2.34 |
| 15   | 2.45  | 2.45 | 2.40 | 2.59 | 2.42 | 2.06 | 2.31 | 2.51 | 2.73 | 4.42 | 2.15 | 2.35 |
| 16   | 1.72  | 2.63 | 2.63 | 2.10 | 2.85 | 2.18 | 2.15 | 1.94 | 2.97 | 2.24 | 2.61 | b    |
| 17   | 0.63  | 1.88 | 1.47 | 1.71 | 1.80 | 0.65 | 1.52 | 2.06 | 1.48 | 1.14 | 1.04 |      |
| 18   | 1.67  | 1.95 | 1.42 | 1.55 | 2.76 | 1.15 | 1.24 | 1.46 | 0.94 | 1.02 | 1.12 | 1.20 |
| 19   | 2.23  | 2.61 | 2.30 | 2.29 | 2.34 | 2.48 | 2.00 | 2.55 | 2.18 | 2.34 | 2.37 | 2.45 |
| 20   | 1.74  | 2.20 | 2.19 | 2.13 | 2.21 | 2.07 | 1.71 | 2.13 | 1.88 | 2.11 | 1.93 | b    |
| D-1  | 1.44  | 1.57 | 1.54 | 1.45 | 1.23 | 1.57 | 1.46 | 1.34 | 1.50 | 1.47 | 1.22 | 1.28 |
| 2  | 1.45  | 1.49 | 1.86 | 1.61 | 1.63 | 1.64 | 1.62 | 1.79 | 1.72 | 1.67 | 1.65 | 0.63 |
| 3  | 2.63  | 2.44 | 2.41 | 2.10 | 2.44 | 2.32 | 2.50 | 2.30 | 2.14 | 2.28 | 2.07 | 2.20 |
| 4  | 1.50  | 1.09 | 1.67 | 1.42 | 1.31 | 1.56 | 1.47 | 1.71 | 1.61 | 1.66 | 1.14 | 1.57 |
| 5  | 1.67  | 1.73 | 2.10 | 1.66 | 1.82 | 1.84 | 1.95 | 1.95 | 1.64 | 1.71 | 2.11 | 1.75 |
| 6  | 1.70  | 1.60 | 1.61 | 1.73 | 1.58 | 1.48 | 1.71 | 1.69 | 1.53 | 1.40 | 1.43 | 1.16 |
| 7  | 1.45  | 1.82 | 2.02 | 2.06 | 1.80 | 2.20 | 2.09 | 2.15 | 1.97 | 2.42 | 1.97 | 2.19 |
| 8  | 2.09  | 2.27 | 2.39 | 1.46 | 2.23 | 1.79 | 2.24 | 2.13 | 1.81 | 2.28 | 1.91 | 1.78 |
| 9  | 1.91  | 1.95 | 2.19 | 2.14 | 2.05 | 2.03 | 2.18 | 1.98 | 2.04 | 2.45 | 1.98 | 2.19 |
| 10   | 1.77  | 1.97 | 2.04 | 1.69 | 1.55 | 1.65 | 1.88 | 1.86 | 1.20 | 1.63 | 1.41 | 1.31 |
| 11   | 1.88  | 1.55 | 1.68 | 0.74 | 0.65 | 1.85 | 1.70 | 1.83 | 1.17 | 1.17 | 1.02 | 1.44 |
| 12   | 1.81  | 1.86 | 2.05 | 1.73 | 1.69 | 1.56 | 2.03 | 1.82 | 1.80 | 1.70 | 2.16 | 1.76 |
| 13   | 2.30  | 2.56 | 2.50 | 2.30 | 2.38 | 2.27 | 2.67 | 2.60 | 2.12 | 2.05 | 2.69 | 2.52 |
| 14   | 1.79  | 1.88 | 1.92 | 1.73 | 1.88 | 1.88 | 1.82 | 1.86 | 1.92 | 2.23 | 1.88 | 1.76 |
| 15   | 1.18  | 1.53 | 1.22 | 0.94 | 1.27 | 1.16 | 1.19 | 1.26 | 0.92 | 1.47 | 1.20 | 1.06 |
| 16   | 1.99  | 2.07 | 1.86 | 1.89 | 0.64 | 1.61 | 1.73 | 2.06 | 2.24 | 1.83 | 2.10 | 2.15 |
| 17   | 1.87  | 1.98 | 1.85 | 1.84 | 1.89 | 1.89 | 1.53 | 2.09 | 1.80 | 1.97 | 1.97 | 1.88 |
| 18   | 1.99  | 2.29 | 1.86 | b    | 1.38 | 1.98 | 1.57 | 2.15 | 1.60 | 1.64 | 1.58 | 0.73 |
| 19   | 2.22  | 2.30 | 2.24 |      | 2.00 | 2.72 | 2.37 | 1.81 | 2.28 | 2.40 | 2.28 | 2.37 |
| 20   | 1.25  | 2.14 | 2.28 | 2.10 | 1.64 | 2.27 | 1.79 | 2.12 | 2.06 | 2.01 | 2.08 | 2.24 |

<sup>a</sup>Samples analyzed at Washington Regional Medical Center, Fayetteville, AR.

<sup>b</sup>Value not reported.

## Appendix II. T<sub>2</sub> worker instructions.

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1. Items you will receive:
  - a) boots
  - b) leather gloves
  - c) laundering instructions
  - d) heavy duty liquid detergent
  - e) rubber gloves
  - f) cotton gloves
2. Beginning the morning before the T<sub>2</sub> 2,4-D application day:
  - a) wear freshly laundered clothing (see instructions below)
  - b) wear new boots
  - c) wear new leather gloves if you are doing work in which gloves are needed.
3. On T<sub>2</sub> application day:
  - a) wear freshly laundered long sleeve shirts and pants, both cotton
  - b) wear new boots
  - c) wear rubber gloves, when mixing, filling your application device, or unplugging nozzles.
  - d) wear leather gloves during herbicide application
  - f) wash hands before rest stops (before using urine containers, eating or using tobacco)
  - g) Bathe and change into clean clothing as soon as possible after work.
  - h) abide by all instructions given by field crew supervisor to help minimize exposure.
4. All clothing worn during the urine-collection days following the 2nd application day must also have been laundered according to instructions. You will receive a new pair of cotton work gloves to be worn during this time if you engage in activities where gloves are needed. Do not wear gloves previously used in herbicide application.

### Laundering Pesticide Contaminated Clothing

The following are laundering instructions for clothing contaminated with Weedone 170® or Tordon 101 R®.

1. Wash clothing in washing machine separate from the family wash, using as hot of water as possible. Washing in hot water removes more pesticide from the clothing than washing in other water temperatures. Remember . . the hotter, the better. Avoid cold water washing! Although cold water washing might save energy, cold water temperatures are relatively ineffective in removing pesticides from clothing.
2. Use a heavy duty liquid detergent. Detergent will be provided for you to take home.

Appendix III. Observations made in the field.

| Worker # | T <sub>1</sub>  | T <sub>2</sub>   |
|----------|---|--|
| A-1      |   | Had leak in backpack container.  |
| A-2      | Wore chaps covering the legs from waist to knees. Wore baseball cap.                        | Wore baseball cap.   |
| A-3      | Wore baseball cap.  | Wore baseball cap.   |
| A-4      | Wore baseball cap.  | Wore baseball cap.   |
| A-5      | Wore baseball cap and chaps.  | Top of backpack container leaked when first filled. Wore chaps and baseball cap. |
| A-6      | Wore baseball cap and chaps.  | Wore baseball cap.   |
| A-7      | Wore baseball cap.  | Wore chaps and baseball cap.   |
| A-8      | Wore chaps and baseball cap.  | Wore chaps and baseball cap.   |
| A-9      | Wore baseball cap.  | Wore baseball cap.   |
| A-10     | Wore no hat.  | Wore no hat.   |
| A-11     | Wore baseball cap.  | Wore no hat.   |
| A-12     | Wore chaps and baseball cap.  | Wore baseball cap.   |
| A-13     | Wore baseball cap.  | Wore baseball cap.   |
| A-14     | Wore baseball cap.<br>Was diagnosed as having hepatitis within 2 weeks of the spray period. | Wore baseball cap.   |
| A-15     | Wore glasses. Wore chaps and baseball cap.  | Wore glasses and baseball cap.   |
| A-16     | Wore baseball cap and chaps.  | Wore baseball cap.   |
| A-17     | Wore baseball cap.  | Wore baseball cap and chaps.   |
| A-18     | Wore baseball cap. Applied Sevin dust on Day 4.   | Sprayer leaked on trousers.<br>Wore baseball cap.                                |
| A-19     | Wore leggings covering from knees to ankles. Wore baseball cap.                             | Wore leggings. No baseball cap.  |
| A-20     | Wore baseball cap and chaps.  | Wore baseball cap.   |

Appendix III (cont.)

| Worker # | T <sub>1</sub>   | T <sub>2</sub>  |
|----------|--|---|
| B-1      | Had on partial boots that got contaminated. Gloves (leather) were wet with concentrate. Wore glasses and a hard hat. Used a rose and flower aerosol on days 1 & 11   | Had a leaky injector and it leaked through his gloves and onto his hand. Also splashed some on his face. Wore glasses and a hard hat. |
| B-2      | Spilled concentrate on his hand. Kept a rag in his pants' pocket that had concentrate on it. Wore leather gloves, glasses, and a hard hat.                           | Wore gloves, glasses, and hard hat.   |
| B-3      | Spilled concentrate on hands, pants, boots, and gloves. Wore leather gloves, hard hat, and glasses.  | Spilled small amount of concentrate on boots. Wore gloves, hard hat, and glasses.   |
| B-4      | Spilled concentrate on gloves. Wore glasses and hard hat.  | Wore glasses and hard hat. Did not take 1/2 hour break as the other workers did.  |
| B-5      | Gloves were damp with concentrate. Also spilled some on pants and boots. Wore glasses and hard hat.  | Wore glasses and hard hat.  |
| B-6      | Gloves were soaked with concentrate, so much so that the color of the gloves covered his hands. Also splattered concentrate on his boots. Wore hard hat and glasses. | Did not apply with the others, but instead applied 1 day later. Wore hard hat and glasses.  |
| B-7      | Spilled concentrate on gloves and on hands. Wore glasses and hard hat.   | Spilled a small amount of concentrate on gloves. Wore glasses and hard hat.   |
| B-8      | Had not worked with a phenoxy herbicide in 3 years. Wore gloves and hard hat, but no glasses.  | No glasses, but wore hard hat.  |
| B-9      | Had not worked with a phenoxy herbicide in 2 years. Wore hard hat, but no glasses or gloves.   | Wore hard hat and rubber gloves, but no glasses.  |



Appendix III (cont.)

| Worker # | T <sub>1</sub>   | T <sub>2</sub>  |
|----------|--|---|
| B-10     | Had not worked with a phenoxy herbicide in 2 years. Wore hard hat, no gloves or glasses.                       | Wore hard hat.  |
| B-11     | Had not worked with a phenoxy herbicide in 5 years. Wore hard hat, no glasses or gloves.                       | Wore hard hat and rubber gloves. but no glasses.      |
| B-12     | Had used Tordon 101 R 5 days prior to T <sub>1</sub> . Wore leather gloves, a hard hat, and glasses.           | Wore hard hat, glasses, and leather gloves.           |
| B-13     | Had not worked with a phenoxy herbicide in 3 years. Wore leather gloves, hard hat, and glasses.                | Wore hard hat, leather gloves, and glasses.           |
| B-14     | Wore leather gloves, hard hat, and glasses.  | Wore leather gloves, hard hat, and glasses.           |
| B-15     | Wore leather gloves, glasses, and hard hat.  | Wore leather gloves, glasses, and hard hat.           |
| B-16     | Wore hard hat, but no gloves or glasses.   | Wore hard hat and gloves, but no glasses.             |
| B-17     | Wore hard hat, leather gloves and safety glasses. Had been 3 months since last worked with a phenoxy herbicide | Wore hard hat, leather gloves, and safety glasses.    |
| B-18     | Had last used a phenoxy herbicide 3 months prior. Wore safety glasses, leather gloves, and a hard hat.         | Wore hard hat, leather gloves, and safety glasses.    |
| B-19     | Had not worked with a phenoxy herbicide in 5 months. Wore safety glasses, leather gloves, and a hard hat.      | Wore hard hat and safety glasses, and leather gloves. |
| B-20     | Last worked with a phenoxy herbicide 5 months prior. Wore hard hat, leather gloves and safety glasses.         | Wore hard hat, safety glasses, and leather gloves.    |



Appendix III (cont.)

| Worker # | T <sub>1</sub>  | T <sub>2</sub>   |
|----------|---|--|
| C-1      | Had previous exposure to Tordon 101 R 1 week prior to T <sub>1</sub> . Spilled concentrate on hands, face, neck, and clothes. Wore no gloves, glasses; wore hat. Is a smoker and tobacco chewer. His duties included filling the hypohatchet for each member of the crew. | Wore leggings. Spilled some concentrate on face, shirt, and shoe. Wore hard hat and leather gloves.                  |
| C-2      | Had previous exposure 1 week prior to T <sub>1</sub> . Wore leather gloves, hard hat, and glasses. Spilled concentrate on hands, arms, pants, and boots. Smoked and chewed tobacco.   | Spilled small amount of concentrate on shirt and shoe. Wore leggings, hard hat, leather gloves, and glasses.         |
| C-3      | Had previous exposure 1 week prior to T <sub>1</sub> . Spilled some concentrate on hands, face, and pant legs. Smokes and chews tobacco. Wore hard hat, cotton gloves, and glasses.   | Spilled a very small amount of concentrate on pants and shoes. Wore leggings, hard hat, glasses, and leather gloves. |
| C-4      | Had previous exposure 1 week prior to T <sub>1</sub> . Spilled concentrate on face, arms, hands, shirt, boots, and pants. Wore hard hat, but no gloves or glasses. Smokes tobacco.  | Spilled a small amount of concentrate on face, shirt, pants, and boots. Wore hard hat and gloves.                    |
| C-5      | Had previous exposure to Tordon 101 R 1 week prior to T <sub>1</sub> . Had concentrate spilled on face, arms, and hands. Hose broke on his bottle and concentrate leaked on his clothing. Wore hard hat and cotton gloves.  | Spilled concentrate on shirt and pants. Chewed tobacco.  |
| C-6      | Had previous exposure 1 week prior to T <sub>1</sub> . When putting on his bottle, he reported splashing concentrate on his face, hands, arms, shirt, pants, and tennis shoes. Wore leather gloves and hard hat. Smoked and chewed tobacco.                               | Spilled small amounts of concentrate on his face, clothes, and shoes.  |

Appendix III (cont.)

| Worker # | T <sub>1</sub>  | T <sub>2</sub>   |
|----------|---|--|
| C-7      | Had previous exposure 1 week prior to T <sub>1</sub> . Tube was pulled off his bottle and his pants got soaked with concentrate. Also, some concentrate spilled on his face, arm, and hand. Wore hard hat and cotton gloves. Smoked and chewed tobacco. | Spilled small amount of concentrate on face, shirt, pants, and boots. Wore leggings, hard hat, and leather gloves.   |
| C-8      | Spilled concentrate on his hands and shirt. Wore hard hat, leather gloves, but no glasses.  | Spilled concentrate on his face, hands, and trousers. Wore hard hat, leather gloves, and glasses.  |
| C-9      | Spilled concentrate on hands and trousers. Wore goggles and hard hat, but no gloves.  | Spilled concentrate on his face, hands and trousers. Wore hard hat, leather gloves, and glasses.   |
| C-10     | Spilled concentrate on his hands and trousers. Wore hard hat and glasses, but no gloves.  | Spilled concentrate on face, hands, and trousers. Wore hard hat, glasses, and leather gloves.  |
| C-11     | Applied 2,4-D to thistle 5 days before T <sub>1</sub> . Spilled concentrate on his hands, boots, and trousers. Wore hard hat, cotton gloves, and glasses.   | Spilled concentrate on his face, hands, and trousers. Wore hard hat, leather gloves, and glasses. Applied Coopertox fly spray for cattle during the study. |
| C-12     | Last worked with a phenoxy herbicide 9 months previously. Spilled concentrate on his hands and trousers. Wore hard hat, glasses, but no gloves.   | Spilled concentrate on his face, hands, and trousers. Wore leather gloves, glasses, and hard hat.  |
| C-13     | Spilled concentrate on his lips, shirt, and pants. Wore safety glasses, hard hat, and leather gloves.   | Spilled concentrate on his face, shirt, and pants. Wore hard hat, safety glasses, and leather gloves.  |
| C-14     | Spilled concentrate on his shirt, pants, face, and lips. Wore hard hat, safety glasses, and leather gloves.   | Spilled concentrate on his face, shirt, and pants. Wore safety glasses, hard hat, and leather gloves.  |
| C-15     | Got concentrate on his face, including eyes and lips. Also on his shirt and boots. Wore hard hat, leather gloves, and safety glasses.   | Spilled concentrate on his face, shirt, and pants. Wore safety glasses, hard hat, and leather gloves.  |

Appendix III (cont.)

| Worker # | T <sub>1</sub>   | T <sub>2</sub>   |
|----------|--|--|
| C-16     | Had worked with a phenoxy herbicide in the 2 weeks prior to the study. Spilled concentrate "all over" his skin, shirt, pants, and boots. Wore glasses, but no gloves. Did not wear a hat, but instead wrapped a towel around his head. | Again spilled concentrate "all over," including shirt, pants, and boots. Wore glasses. Did not wear a hat, but instead wrapped a towel around his head. Also had sprayed Roundup during the study.               |
| C-17     | Had exposure to a phenoxy herbicide 3 weeks prior to T <sub>1</sub> . Spilled concentrate all over, including getting some in his eyes and on his shirt and pants. Wore no hat, glasses, or gloves.                                    | Spilled concentrate on his shirt, pants, face, hands, arms, and back. Wore rubber gloves, but no hat or glasses. During the study, he also sprayed Garlon 4, Garlon 3A, Roundup, and Velpar.                     |
| C-18     | Spilled concentrate on his face and arms, shirt and pants. Wore baseball cap, but no glasses or gloves.  | Got concentrate on his face, hands, eyes, shirt, and pants. Wore rubber gloves and a baseball cap, but no glasses.   |
| C-19     | Spilled concentrate on his face, arms, hands, shirt, and pants. Wore baseball cap, but no gloves or glasses.   | Spilled concentrate on his face, hands, shirt, pants, and boots. Wore baseball cap and rubber gloves, but no glasses. On T <sub>2</sub> after work, he sprayed malathion on his garden for approximately 30 min. |
| C-20     | Spilled concentrate on his hand, arm, shirt, and pants. Wore leather gloves, baseball cap, glasses, and a bandana.   | Spilled concentrate on arm, hands, face, pants, shirt, and boots. Wore rubber gloves, baseball cap, glasses, and a bandana.  |
| D-1      | Wore hard hat and gloves with leather palms and cotton uppers. Had on hard plastic shin guards for protection against the axe.   | Spilled some concentrate on his gloves. Had on gloves, hard hat, and shin guards.  |
| D-2      | Wore gloves with leather palms and cotton uppers, and a hard hat, and shin guards.   | Spilled concentrate on his gloves. Wore shin guards and a hard hat.  |
| D-3      | Duties included filling all the bottles for T <sub>1</sub> . Wore rubber gloves when doing this. When out applying, he wore shin guards, gloves, and a hard hat.   | Some concentrate soaked through his gloves and got on his hands. Again he wore shin guards, hard hat, and leather gloves.  |

Appendix III (cont.)

| Worker # | T <sub>1</sub>   | T <sub>2</sub>  |
|----------|--|---|
| D-4      | Got some concentrate on his hands. Wore gloves with leather palms and cotton uppers, hard plastic shin guards, and hard hat.   | Spilled some concentrate on his gloves. Wore gloves (leather), hard hat, and shin guards.   |
| D-5      | Spilled some concentrate on his shirt. Wore gloves with leather palms and cotton uppers, hard plastic shin guards, and a hard hat.   | Spilled concentrate on his gloves. Wore leather gloves, hard hat, and shin guards.  |
| D-6      | Got some concentrate on his gloves. Wore gloves with leather palms and cotton uppers, hard hat, shin guards, and glasses.  | Some concentrate went through his gloves and onto his fingers. Wore leather gloves, hard hat, shin guards, and glasses.   |
| D-7      | Wore gloves with leather palms and cotton uppers, shin guards, and a hard hat.   | Spilled concentrate on his gloves. Wore leather gloves, hard hat, and shin guards.  |
| D-8      | Wore gloves with leather palms and cotton uppers, shin guards, and a hard hat. Applied Sevin sometime during the study.  | Some concentrate went through his gloves and onto his fingers. Wore leather gloves, hard hat, and shin guards.  |
| D-9      | Duties included carrying a large jug out into the field to refill all the bottles. Spilled some on his arm while carrying the jug. Wore gloves with leather palms and cotton uppers, hard hat, shin guards, and glasses. | Spilled some concentrate on his gloves. Wore leather gloves, hard hat, shin guards, and glasses. Applied malathion, thiodan, Sevin, and Maneb sometime during the study (did not say exactly when). |
| D-10     | Duties included filling and capping all the bottles. Wore rubber gloves to do so. Spilled some concentrate on his arm. Wore gloves with leather palms and cotton uppers, hard hat, and shin guards.                      | Some concentrate went through his gloves and clothes, and onto his skin. Wore leather gloves, hard hat, and shin guards.  |
| D-11     | Wore gloves with leather palms and cotton uppers, hard hat, and shin guards.   | Some concentrate got on his gloves. Wore leather gloves, hard hat, and shin guards.   |

Appendix III (cont.)

| Worker # | T <sub>1</sub>  | T <sub>2</sub>   |
|----------|---|--|
| D-12     | Got concentrate on his fingers and in his mouth. Wore gloves with leather palms and cotton uppers, hard hat, and shin guards. Applied malathion and Sevin during the study.   | Got concentrate on his gloves and could smell it on his fingers. Wore hard hat, leather gloves, and shin guards.   |
| D-13     | Got squirted in the face, eyes, hands, arms, and shirt with concentrate. Wore gloves with leather palms and cotton uppers, shin guards, and hard hat.   | Got concentrate on gloves, fingers, and pants. Wore leather gloves, shin guards, and a hard hat. Applied Maneb, liquid Sevin (50%), Spectricide, malathion, and Zineb sometime during the study (did not say exactly when).                          |
| D-14     | Duties included capping the squirt bottles when filling. Wore gloves with leather palms and cotton uppers, shin guards, and hard hat.   | Concentrate soaked through his leather gloves and onto his hands. Wore hard hat, leather gloves, and shin guards.  |
| D-15     | Got concentrate on his hands, wore gloves with leather palms and cotton uppers, shin guards, and a hard hat.  | Spilled concentrate on his gloves. Wore leather gloves, hard hat, and shin guards.   |
| D-16     | Squirt bottle leaked and got on his left hand and all over his clothes. Reportedly Could smell concentrate on the skin and could taste it on his lips and in his sweat. Sweated heavily. Wore leather gloves, baseball cap, contact lenses (no safety glasses). | Also got concentrate on his face, neck, hands, shirt sleeves, and pants. Once again the squirt bottle wore out and leaked on him. Wore baseball cap, leather gloves and contact lenses (no safety glasses). Had also applied Sevin during the study. |
| D-17     | Had previous exposure to a phenoxy herbicide 3 weeks prior to T <sub>1</sub> . Squirt bottle leaked and got concentrate on his hands and pants. Wore cotton gloves, baseball cap, and glasses.  | Squirt bottles wore out and leaked over hands, pants, and shirt. Also got concentrate on neck and face. Wore leather gloves, hard hat, and glasses. Could be noticed in sweat and and tasted on lips.  |



Appendix III (cont.)

| Worker # | T <sub>1</sub>  | T <sub>2</sub>   |
|----------|---|--|
| D-18     | Squirt bottle leaked and got on his hands, and then into his eyes. Wore baseball cap, but no gloves.                    | Squirt bottle wore out and got concentrate on his hands, face, shirt, and pants. Wore baseball cap and leather gloves.                     |
| D-19     | Squirt bottle leaked and got on his hands, shirt, and pants. Wore baseball cap and one cotton glove (on the back hand). | Squirt bottle wore out and leaked on his hands, sleeves, pants, and got onto his face. Wore a cap and leather gloves (2 gloves this time). |
| D-20     | Squirt bottle leaked onto his hands. Wore a cap, glasses, and cotton gloves.  | Squirt bottle wore out and leaked on his hands, shirt sleeves, and pants. Wore cap, leather gloves, and glasses.                           |



Appendix IV. Summary of observations and further inquiries after sample analysis.

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Group A

- A) Workers 1-10 reported having a lot of problems with backpack leaks.
- B) No. 18 reported that his sprayer leaked on his trousers during T<sub>2</sub>.
- C) Worker A-5 had a higher exposure levels in T<sub>2</sub> than in T<sub>1</sub>. He reported his container leaking during T<sub>2</sub>.

Group B

- A) It had rained the night before T<sub>1</sub>.
- B) B-1 had relatively high exposure in this group. He reported that his gloves and boots got contaminated during T<sub>1</sub> and that his injector leaked during T<sub>2</sub>, with the result that some splashed on his face and leaked through his gloves.
- C) The Supervisor filled the injectors for the men. He wore rubber gloves while doing this and reported that the gloves were rinsed with water whenever any chemical was spilled on them.
- D) Workers #10, 11, 12, 13, 15, and 18 had comparatively high exposure levels for this group. There was no indication as to why they had higher levels. They did not report any leaks or spills, but this could be because their records were not completely filled out.
- E) It was noted that some of the injection bars needed repair prior to their use and that gloves were not worn for this purpose. It was not noted who made these repairs.

Group B workers with high exposure:

B-10, B-11, B-12, and B-18 = no indications were given to suggest why they had higher levels.

B-1 had fairly high exposure and he reported being splashed with the compound and his gloves being damp with the solution.

Some injector bars required repair prior to use and gloves were not worn for this. Possibly the injectors were contaminated and some exposure occurred at this point.

No records were made of which workers repaired the injectors.

Group C:

Workers 1-7 at the Mt. View site had exposure the previous week. Data on when the last exposure occurred is conflicting. It is recorded that they used hypohatchet and/or spray from Tuesday (5-18) through Thursday (5-20), that they did not spray from Friday through Sunday, but that they sprayed for 4 hours on Monday (5-17). It is recorded that their last previous exposure was on Wednesday (5-19).

Data of T<sub>1</sub> was Wednesday (5-16).

All the workers in this group (1-7) came in with a slightly elevated Baseline level of 2,4-D as compared to the others in the group.

#### Appendix IV (cont.)

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It was also reported that all workers in the Mt. View group either smoked or chewed tobacco.

Worker C-1 filled the hypohatchet for each man in the group.

Group C Workers 1-7 = Mt. View, AR

8-15 = Deer, AR

16-20 = Pansy (Davis Forestry)

Supervisor from the Deer site reported that the men in his crew had very little exposure ( 3-4 drops on their shirts and pants). Also, most of the men in the group got some on their gloves and boots.

Worker C-7 had the highest total exposure for the 5 days (T<sub>1</sub> and the 4 following days). He reported that the tube on his hypohatchet got pulled off and his pants got soaked.

Worker C-16 reported that he spilled concentrate "all over" himself. He also reported some "minimum" exposure to 2,4-D in the 2 weeks prior to T<sub>1</sub>. But his baseline level of 2,4-D was only very slightly elevated.

Group C for workers 8-12 from the Deer, AR area greater absorbed dose was recorded during T<sub>2</sub> than T<sub>1</sub>. No reasons can be found in the recorded notes.

#### Group D:

- A) Workers #3 and 10 were the mixers. No. 3 filled all the squirt bottles for T<sub>1</sub>. He had the second highest exposure level for T<sub>1</sub> among the crew of Mississippi workers. No. 10, who only mixed and not filled the bottles, had very low exposure levels. These 2 wore rubber gloves at all times.
- B) Worker #9 also had comparatively high exposure levels for this group. He was the worker who carried the jug out to the field to refill all the squirt bottles. He reported spilling some concentrate on his arm.
- C) Worker #13 had comparatively high exposure levels for both T<sub>1</sub> and T<sub>2</sub>. He reported spilling concentrate all over his face and arms and cloths on T<sub>1</sub> and T<sub>2</sub>.
- D) There are two subgroups in Group D: #1-15 were in Mississippi and 16-20 were in Arkansas. There is a considerable difference in age between the two groups.  
In the Mississippi group, 9 of the 15 workers were age 59 and over, and their average age was 53.3.  
In the Arkansas group, 4 of the 5 workers were age 25-28 and their average age was 30.
- E) The Arkansas group (#16-20) had much more exposure than the Mississippi group for both T<sub>1</sub> and T<sub>2</sub>. They reported that during T<sub>1</sub> their squirt bottles leaked on their left hands. The same happened during T<sub>2</sub>; the bottles actually wore out and had to be replaced. Thus, every member of this group reported getting exposure on their hands, face, and clothes.
- F) Workers #8, 9, 12, 13, 16, and 18 reported being exposed to Malathion and Sevin during the course of the study.

## APPENDIX V

# Weedone® 170



## Woody Plant Herbicide

Contains the butoxyethanol ester of 2,4-DP and 2,4-D.  
For controlling mixed brush on utility rights-of-way,  
along highways and solid stands of oak or elm.

### KEEP OUT OF REACH OF CHILDREN CAUTION

#### ACTIVE INGREDIENTS:

\*2,4-Dichlorophenoxypropionic acid,  
butoxyethyl ester ..... 29.3%  
\*\*2,4-Dichlorophenoxyacetic acid,  
butoxyethyl ester\*\*\* ..... 29.9%

#### INERT INGREDIENTS: ..... 40.8%

\*2,4-Dichlorophenoxypropionic acid equivalent  
20.6% by weight or 1.85 pounds per gallon.  
\*\*2,4-Dichlorophenoxyacetic acid equivalent  
20.6% by weight or 1.85 pounds per gallon.  
Isomer specific by AOAC method No. 6.D01-5

EPA Reg. No. 264-222

IN CASE OF EMERGENCY PHONE COLLECT (24 HOURS A DAY) IN U.S.A. (304) 744-3487

#### GENERAL INFORMATION

WEEDONE 170 Woody Plant Herbicide is a concentrated 50-50 combination of 2,4-D and 2,4-DP as the low-volatile butoxyethyl ester.

WEEDONE 170 Woody Plant Herbicide is specifically designed for utilities and other industrial users to control woody plants.

WEEDONE 170 Woody Plant Herbicide mixes with oil or kerosene and emulsifies in water.

WEEDONE 170 Woody Plant Herbicide controls many noxious perennial weeds on uncropped land, such as along highways and drainage ditchbanks.

WEEDONE 170 Woody Plant Herbicide is effective for controlling:

|               |             |                   |
|---------------|-------------|-------------------|
| alder         | currant     | red elm           |
| aspen         | fir         | red maple         |
| bigleaf maple | gooseberry  | salmonberry       |
| birch         | hemlock     | sand shinnery oak |
| blackberry    | honeysuckle | serviceberry      |
| black cherry  | franzosa    | snowberry         |
| blackjack oak | oaks        | spruce            |
| buckbrush     | pine        | sycamore          |
| black locust  | poison ivy  | tulip poplar      |
| ceanothus     | poison oak  | willow            |
| chamise       | poplar      | winged elm        |
| coffeeberry   | red elder   | yerba santa       |

(and many other species)

**TO PREPARE A SPRAY:** Add one-half the required amount of oil or water to the spray tank, then add this product with agitation and finally the balance of the water or oil with continued agitation.

If this material is to be used in straight oil mixtures, do not let water get into it or the finished mixture.

This material forms an emulsion in water — not a solution. This tends to separate on standing. Provide agitation to prevent such separation and ensure a uniform spray mixture.

#### DIRECTIONS

##### FOLIAGE STEM METHOD

This is the standard method for high volume sprays along fencerows, highways and rights-of-way. Use it as a "first spray" on thick brush composed of mixed species.

Apply spray to both foliage and stems of all plants from the time foliage is fully developed until plants begin to go dormant. For effective control, all leaves, stems and suckers must be thoroughly wet to ground line. Some regrowth may be expected on resistant species, such as ash, maple, oak and persimmon.

Add 1 to 1½ gallons of WEEDONE® 170 Woody Plant Herbicide to 85

100 gallons of water. Mix thoroughly before spraying. Use 200 to 600 gallons of spray mixture per acre depending on height and density of brush.

##### BASAL BARK METHOD

Thoroughly wet the base and root collar of all stems until the spray collects around the root collar at ground line. This spray may be applied in any season. Apply WEEDONE 170 Woody Plant Herbicide with the basal bark method on scattered brush or as a "second spray" on species resistant to a first foliage spray.

Mix 3 to 4 gallons of WEEDONE 170 Woody Plant Herbicide in 100 gallons of oil. Apply with low volume knapsack sprayer or power equipment. Concentration will depend on species present, volume of spray used, and season applied. Use a coarse spray to avoid drift.

##### MODIFIED BASAL METHOD

Drench the base of plants, then wet the lower 4/5 of remaining stems and leaves to run-off. Treat when brush is in full foliage. This method may be used when susceptible species have been controlled by prior sprays and resistant species such as maple and oak remain. Drenching the base of the plant and wetting all stems to run-off is essential for complete control.

**Early season spraying:** Add 1 to 1½ gallons of WEEDONE 170 Woody Plant Herbicide to 10 gallons of diesel oil and mix thoroughly. Add this mixture to 89 gallons of water.

**During dry weather or the latter part of spray season:** Add 1½ gallons of WEEDONE 170 Woody Plant Herbicide to 15 gallons of diesel oil and mix thoroughly. Add this mixture to 83½ gallons of water. Agitate thoroughly before spraying, particularly if material is allowed to stand for more than one hour after mixing.

##### CUT SURFACE

**Stump:** This method can be used at any time of year, but it is more effective when applied as soon as possible after trees are cut. Spray the entire stump, particularly bark and exposed roots. A thorough drenching is essential for complete control.

Use this method after original or capital clearing. It is the first step toward a chemical brush control program on newly cleared highways and rights-of-way. Spray is most effective and economical on stumps 3 to 4 inches and larger.

Mix 3 to 4 gallons of WEEDONE 170 Woody Plant Herbicide in 100 gallons of oil. Apply with low volume knapsack sprayer using solid cone nozzle of medium orifice.

**Frill:** Make a frill by using an axe to cut overlapping notches in a continuous ring around the trunk near its base. Cut through the bark, but do not remove chips. This method is recommended for cull trees 5 to 6 inches in diameter and over. Treat freshly cut frills at any time of the year. Mix 3 to 4 gallons of WEEDONE 170 Woody Plant Herbicide in 100 gallons of oil. Pour in as much of this mixture as the frill will hold without wasting chemical.





# TORDON\* 101R

## FORESTRY HERBICIDE

*For Controlling Unwanted Trees Via Cut Surface Treatments*

#### ACTIVE INGREDIENTS:

Picloram (4-amino-3,5,6-trichloropicolinic acid) as the triisopropanolamine salt 5.4%  
2,4-Dichlorophenoxyacetic acid as the triisopropanolamine salt 20.5%

#### INERT INGREDIENTS:

Acid Equivalents: Picloram — 1.0% 2,4-Dichlorophenoxyacetic acid — 11.2%  
E.P.A. Registration No. 464-510 EPA Est. 464-MK-1

PRECAUCION AL USUARIO: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

TRANSLATION: (TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

KEEP OUT OF THE REACH OF CHILDREN

#### WARNING

HARMFUL OR FATAL IF SWALLOWED • CAUSES EYE INJURY

MAY CAUSE SKIN IRRITATION • COMBUSTIBLE LIQUID

Avoid Contact with Eyes, Skin and Clothing • Wash Thoroughly After Handling • Keep Container Closed • Do Not Store Near Food or Feed • Keep Away from Heat and Open Flame • Do Not Cut or Weld Container • Do Not Drink Solution • Do Not Store in Open or Unlabeled Containers

Contains ethylene glycol. If swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Get medical attention. Never give anything by mouth to an unconscious person.

In case of eye contact, promptly flush with plenty of water, and get medical attention. Remove contaminated clothing and wash before reuse.

In case of an emergency endangering life or property involving this product, call collect:  
**517-636-4400**

**AGRICULTURAL CHEMICAL**  
Do Not Ship or Store with Foods, Feeds, Drugs or Clothing.

**18.93 L/ 5 gal**

ADDENDUM

(This Addendum is the protocol followed during the study)

Protocol  
for

"Exposure of Forestry Applicators Using Formulations  
Containing 2,4-D in Non-Aerial Applications"

- I. Principal Investigator: Terry L. Lavy, Ph.D.  
Alzheimer Laboratory  
University of Arkansas  
Fayetteville, Arkansas 72701
- II. Project Coordinator: Logan A. Norris, Ph.D.  
Pacific Northwest Forest and Range  
Experiment Station  
3200 Jefferson Way  
Corvallis, Oregon 97331
- III. Additional Project Designers:
- |                   |                  |
|-------------------|------------------|
| Dr. John Neisess  | Mr. Werner Braun |
| Dr. W.H. Lawrence | Dr. Glenn Glover |
| Ms. Rinda Flynn   |                  |
- IV. Sponsoring Organization: USDA Forest Service
- V. Objectives of the Study: To determine the dosage received by applicators of 2,4-D using conventional practices vs special procedures and protective gear during Hypo-Hatcher<sup>®</sup>, hack-and-squirt, tubular injection bar (e.g., Jim-Gen<sup>®</sup>), and backpack foliar applications.
- VI. Project Parameters: The amount of 2,4-D that is excreted in urine will be measured for each worker as a determination of exposure.
- VII. Relevance of the Study: The degree of applicator exposure to pesticides has been one of the primary criteria used in determining whether RPAR (Rebuttable Presumption Against Registration) proceedings should be initiated for certain pesticides. Lavy (1978) conducted a study of 2,4,5-T applicator exposure in forestry where both ground and aerial application techniques were used. The excretion of the herbicide in urine was shown to be a reliable index of applicator internal dose. He conducted a similar study of 2,4-D aerial applicator exposure in which exposure and internal dose resulting from normal procedures were compared with exposure and internal dose received when



special protective gear and procedures were employed (Lavy, 1980). Similar data are needed to permit accurate assessment of risk for 2,4-D ground applicators in the forest. Lavy's 2,4,5-T study showed that ground applicator internal dose varied with the type of application method. The 2,4-D aerial application study showed that the use of extra protective gear and the implementation of special handling and application procedures reduced applicator exposure and dose. This study is designed to measure the amount of 2,4-D excreted in the urine of ground applicators and show the degree to which this dose is influenced by the method of application and use of protective gloves and special handling procedures.

VIII. General Research Plan: The study will be conducted in the forests of Arkansas or other southern and/or southeastern states. The internal dose received by workers engaged in four different kinds of application techniques Hypo-Hatcher<sup>®</sup>, hack-and-squirt, tubular injection bar and backpack foliar spray will be monitored during two separate ground application tests. During the first test (T-1) application crews will work for one day making a specified application using their normal procedures and wearing their normal clothing. For the next five days, the workers will not be involved in 2,4-D applications. At this point the second test will begin. During the second test (T-2), workers will wear protective gloves and receive special instructions concerning pesticide handling and proper application methodology which may reduce exposure. After this one day of work the crews will not be involved in further applications of 2,4-D for 4 days. Throughout both test periods, all the urine voided by each participant will be collected in 24-hr intervals beginning one day before the application day, on the application day and continuing for four days following.

Twenty workers will be monitored for each of the 4 application methods. This means there will be a total of 80 crew members involved in the study, all of which are scheduled to participate in both tests.

IX. Sample Generation:

20 workers x 4 methods x 2 application tests x 6

24-hr urine samples/treatment = 960 24-hr urine samples

to be analyzed for 2,4-D content.

Creatinine analysis: 960

X. Application - Timing, Climatic Conditions, Spray Material, Field Personnel, Unit of Work, Sample Handling, Quality Control:

A. Sample Collection and Timing: The field aspects of this study are designed to get underway in May 1982, with applications to be completed by December 1982. Chemical analyses will be on-going as samples are collected for the various application methods and should be completed by February 1983. Data analysis and report preparation are planned for a July 31, 1983 completion date.

B. Climatic Conditions: Weather conditions during application will be noted. It is our intent to conduct T-1 and T-2 for each method of application one days having similar environmental conditions, so as to reduce variability occurring due to weather, temperature, etc. All label requirements as well as pertinent state and federal regulations will be followed.

C. Spray Material: The spray material to be used for Hypo-Hatchet<sup>®</sup>, hack-and-squirt, and tubular injection bar applications will be Tordon 101R. The spray material to be used for backpack foliar spray will be Weedone 170. Lots of each material used will be analyzed to verify concentration of active ingredient. Spray materials will be furnished to the cooperating crews by the principal investigator.

D. Field Personnel: Personnel for the tests will be selected from crew members who normally do this type of work in the test area. In addition to their normal supervision, additional support personnel will be on hand to fill out individual worker data forms, record data, and transport samples.

E. Unit of Work: The unit of work (length of time of potential exposure on T-1 and T-2 treatment days) will be a typical work day - scheduled for a minimum of 5 hours and a maximum of 8 hours.

XI. Sample Handling: One day before mixing or applying the 2,4-D, each worker's urine will be collected. This pre-application 24-hr urine sample will provide a measure of any background interference in the analysis and will determine whether any 2,4-D is present in the worker's urine immediately prior to participating in this test. Each crew member will collect his/her total urine by 24-hr intervals starting with the second urine sample each morning (after getting up to stay up) and ends with the first urine sample the next morning. Collection will begin 1 day before the application day, on the application day, and continue for 4 days after treatment. Total urine excreted over each 24-hr period will make up each sample. Workers will be instructed to take special caution in order to prevent contamination of the urine during these collection periods.

The Altheimer Pesticide Residue Laboratory at the University of Arkansas, will perform the analytical work on the urine samples. A Field Crew Supervisor will be responsible for seeing that urine samples are picked up from participants daily or every two days and placed in a central cooler. Samples will be weighed and aliquots of the total urine samples transported to the lab, where they will be analyzed for total 2,4-D and creatinine content. Aliquots of the samples will be kept cool prior to analysis and stored until the samples are no longer needed.

XII. Quality Control:

- A. Field Fortification: The Field Crew Supervisor will pipette 5 ml of a known 2,4-D acid stock solution into 50 ml aliquots of urine taken from samples excreted by selected workers on the pre-application day. These samples will constitute approximately 5% of the field samples and will be handled the same as the other urine samples.
- B. Blind Laboratory Spikes: A series of blank urine samples will be fortified with known concentrations of 2,4-D acid at the Altheimer Laboratory. Rinda Flynn will prepare these samples and place them randomly among field samples coming into the laboratory for analysis by our analytical chemist. The number of samples will approximate 8% of the total.
- C. Outside Laboratory Checks: Dr. L.A. Norris will prepare urine samples containing known concentrations (0-20 ppm) of 2,4-D acid. The concentration of 2,4-D in the samples will be known to him but unknown to our analytical chemist. In addition, stock solutions containing 0, 1, 2, 4, 8, and 20 ppm 2,4-D acid will be prepared by Dr. Norris in Corvallis, Oregon and shipped to the Altheimer Laboratory.
- D. Altheimer Laboratory Confirmation: Control urine samples will be fortified with known 2,4-D concentrations to allow percent recovery and sensitivity measurements to be made. Sensitivity equal to, or greater than, that in the past 2,4-D study (0.04 ppm) is anticipated (Lavy 1980). Every 10th sample injected into the gas chromatograph will be a standard of known 2,4-D concentration to maintain quality control throughout the study. Confirmatory tests will be made using two different gas chromatography columns.
- E. GCMS Confirmation: Selected urine samples will be evaluated by an outside laboratory to confirm the concentration of 2,4-D present.

Herbicide samples will be assayed using a GCMS system to ascertain purity of the treatment concentrate used in the study.

XIII. Plan for Conducting and Reporting Research: (1) Dr. T.L. Lavy, Principal Investigator, will be responsible for execution of the project, making data available to project sponsors and appropriate authorities, and for submitting results of this research to a scientific journal for publication. (2) Dr. L.A. Norris, Project Coordinator, will assist in interpreting and reporting the data. (3) Rinda Flynn, Reserach Assistant, will assist in protocol development, materials procurement, record keeping and project direction.

XIV. Data Computation and Evaluation: All data, information on standard chromatograms, spikes, controls, and unknowns will be preserved until completion of the report and until the Principal Investigator has determined they are no longer necessary. The relationship between T-1 and T-2 for each method will be tested to determine the influence if any, of protective clothing and special precautions. See Appendix III for statistical design.

XV. References:

1. Lavy, T.L. 1978. Measurement of 2,4,5-T exposure of forest workers. 69 p. (Project completion report submitted to National Forest Products Assoc.).
2. Lavy, T.L., J.S. Shepard, and J.D. Mattice. 1980. Exposure measurements of applicators spraying 2,4,5-T in the forest. J. Ag. and Food Chem. 28:626-630.
3. Lavy, T.L., J.S. Shepard, and D.C. Bouchard. 1980. Field worker exposure and helicopter spray pattern of 2,4,5-T in the field. Bull. Environ. Toxicol. Contam. 24:90-96.
4. Lavy, T.L. 1980. Determination of 2,4-D exposure received by forestry

applicators. 73 p. (Project completion report submitted to National Forest Products Assoc.).

5. Lavy, T.L., J.D. Walstad, R.R. Flynn, and J.D. Mattice. 1982. 2,4-D exposure received by aerial application crews during forestry spray operations. J. Ag. and Food Chem. 30:375-381.



## ADDENDUM

### APPENDIX I

All members of the ground application crews will be assayed for exposure to 2,4-D. Twenty workers will be monitored for each application method. Assuming we have 4 crews consisting of 5 members each, an operational plan similar to the one shown on page 10 may be followed.

All participants in this study should avoid any obvious or known sources of 2,4-D exposure for a 1-week period prior to the study. Workers will first be applying the herbicide using a set of parameters described as Test 1 (T-1). The next application will be done according to the parameters specified for Test 2 (T-2). Workers will not be informed of the T-2 stipulations until the day before T-2 pre-application day.

#### T-1 parameters:

- a.) T-1 will employ normal practices for the method of application and crew habits.
- b.) Crew members are expected to follow directions listed on the label of their spray material and to follow all pertinent laws and regulations governing herbicide application.
- c.) Research personnel will not alter or interfere with the normal application operation while observing and recording information.

#### T-2 parameters:

- a.) In order that the urine data will include only the effects of application during the 6-day T-2 period and not any absorption of herbicide from contaminated dirty clothes, workers will be instructed to wear freshly-laundered clothing and will be furnished new boots and work gloves.

Freshly laundered clothing: Workers will be instructed as

to proper laundering procedures for most efficient removal of 2,4-D from their clothing and will be provided with laundry detergent to use. (See Appendix V). They should wear freshly-laundered clothing on the T-2 pre-application and T-2 application days. On the application day apparel should consist of long sleeve shirts and pants, both cotton. All clothing worn during the 4 urine-collection days following T-2 must also have been laundered according to these instructions.

Boots: Since boots may be a primary source of contamination carryover, each worker will be furnished one pair of new boots which will be worn each day during the 6-day T-2 period, beginning on the pre-application day. Workers should do their best not to contaminate boots.

Gloves: Workers will receive a new pair of protective leather gloves to be worn during herbicide application on T-2 application day. These should be worn on T-2 pre-application day if worker needs to wear gloves for any reason. (He should not wear his old contaminated gloves at any time during T-2). Workers will receive a pair of cotton work gloves to be worn for any forestry work done on the 4 days following the T-2 application day.

- b.) All crew members will wear rubber gloves as protective gear to help minimize exposure when filling their application devise and unplugging nozzles. Worker will carry rubber

gloves in Ziploc<sup>®</sup> bag.

- c.) Participants are expected to follow directions listed on the label of their herbicide material and to follow all pertinent laws and regulations governing herbicide application.
- d.) Reserach personnel may control crew actions by suggesting cleaner or better methods.
- e.) During T-2 application the herbicide will be dispensed from a container with a leak-free spigot. Each worker will fill his own application device from the spigot.
- f.) The following instructions should be followed and enforced by the Field Crew Supervisor on the T-2 application day:
  - (1) Method of application used should be done in the proper manner: Hypo-Hatchet<sup>®</sup> - Try to strike tree trunk below belt level. Hack-and-squirt - Try to strike tree trunk below belt level. Backpack - Applicators should 1) not walk through sprayed areas, 2) keep spray off of themselves. Injection Bar - Try to strike tree trunk at its base.
  - (2) Crew members should use care in loading their application device.
  - (3) Hands will be washed before rest stops (before using urine containers, eating or using tobacco). Soap, water, and paper towels will be made available to workers in the forest.
  - (4) Workers will bathe and change clothing as soon as possible after work. Freshly-laundered clothing should be worn that evening and for the balance of the T-2 test period.

The following chart represents staggered application dates for 4 crews making use of 1 method of application. Since each method of application is utilized during a different season of the year, the same type of schedule could be used for all methods. If all 20 participants are working in or near the same area on the same day, there will be no need to arbitrarily divide them into crews and this staggered schedule won't be necessary. One of the sequences listed could be followed instead.

Staggered Application Dates for Conducting T-1 and T-2.

| Day of week: | T | W   | T   | F   | S   | S | M | T   | W   | T   | F   | S  | S  | M  | T  | W |
|--------------|---|-----|-----|-----|-----|---|---|-----|-----|-----|-----|----|----|----|----|---|
| Day #:       | 1 | 2   | 3   | 4   | 5   | 6 | 7 | 8   | 9   | 10  | 11  | 12 |    |    |    |   |
| Crew 1       | X | T-1 | X   | X   | X   | X | Y | T-2 | Y   | Y   | Y   | Y  |    |    |    |   |
| Day #:       |   | 1   | 2   | 3   | 4   | 5 | 6 | 7   | 8   | 9   | 10  | 11 | 12 |    |    |   |
| Crew 2       |   | X   | T-2 | X   | X   | X | X | Y   | T-2 | Y   | Y   | Y  | Y  |    |    |   |
| Day #:       |   |     | 1   | 2   | 3   | 4 | 5 | 6   | 7   | 8   | 9   | 10 | 11 | 12 |    |   |
| Crew 3       |   |     | X   | T-1 | X   | X | X | X   | Y   | T-2 | Y   | Y  | Y  | Y  |    |   |
| Day #:       |   |     |     | 1   | 2   | 3 | 4 | 5   | 6   | 7   | 8   | 9  | 10 | 11 | 12 |   |
| Crew 4       |   |     |     | X   | T-1 | X | X | X   | X   | Y   | T-2 | Y  | Y  | Y  | Y  |   |

T-1 = Normal application day (pre-application day and 4 days following are designed by X.)

T-2 = Protected application day (pre-application day and 4 days following are designated by Y.).

If there are 4 crews and Crew 1's application day is postponed one day, then, according to the chart, Crew 1 and Crew 2 will both be making their treatment on the same day. If there is adequate personnel to supervise at both locations, this should work out fine. If not, workers should continue collecting their urine, and report for application when advised to do so.

## APPENDIX II

### CODES

#### WORKER NUMBERS FOR APPLICATION METHOD A

| <u>Crew 1</u> | <u>Crew 2</u> | <u>Crew 3</u> | <u>Crew 4</u> |
|---------------|---------------|---------------|---------------|
| A 1           | A 6           | A 11          | A 16          |
| A 2           | A 7           | A 12          | A 17          |
| A 3           | A 8           | A 13          | A 18          |
| A 4           | A 9           | A 14          | A 19          |
| A 5           | A 10          | A 15          | A 20          |

Urine collection containers have been labelled for Day 1 through Day 14 for each crew member (two extra days in case of delay due to bad weather). The label on each container consists of 3 parts. The letter indicates application method: A = backpack, B = Injection bar, C = Hypo-hatchet, D = Hack-and-squirt. The second part indicates worker number (1 through 20). The third number indicates day urine sample is collected.

#### URINE SAMPLES

Application method - worker # - day

Example: A5 - 1

A5 - 2

### APPENDIX III

#### Statistical Design

Crews will be defined by having each test done on the same day in the same area and all workers within a crew being from the same company. The design is a split plot with application method as the main plot factor and type of test as the subplot factor. In addition, we will test to see if crew variability is greater than worker variability. The analysis of variance is sketched below.

| <u>Source of Variation</u> | <u>dF</u> | <u>Error term</u> |
|----------------------------|-----------|-------------------|
| Application method (AM)    | 3         | Crew              |
| Crew/AM                    | c - 4     | Worker            |
| Worker/Crew                | 80 - c    | -                 |
| Test                       | 1         | error             |
| AM by test                 | 3         | error             |
| Error                      | 76        |                   |

where c is the total number of different crews (and must be 4 or more). If crew variability is not significant at the .20 level, crew and workers will be pooled and used to test application method.

This analysis will allow us to compare the dose of 2,4-D received by workers in T-1 with that received in T-2 for each of the individual application methods. The intent of the statistical design is not to compare T-1 or T-2 of dissimilar application methods (i.e. backpack foliar spray will not be compared with injection methods).

Using this design and data from a previous study (Lavy, 1980), we will be able to detect a 43% reduction in 2,4-D about 95% of the time and a 24% reduction in 2,4-D about half the time. That is, if in fact, unknown to us, there is a 24% reduction in 2,4-D using the above design, we will be



able to declare our T-1 and T-2 tests significantly different about half the time.

## APPENDIX IV

### Analytical Method for 2,4-D in Urine

1. Place 5 mL of urine into a screw top culture tube.
2. Add 1.0 mL of 10 N NaOH and heat at 85°C for 1½ hr.
3. Cool and add 1 mL of 12 N HCl.
4. Extract with three 10 mL portions of hexane - combine hexane portions in an 8" test tube.
5. Reduce in volume to - 1 mL in a 50° N-Evap under a stream of dry nitrogen.
6. Add 1 mL of BF<sub>3</sub>/BuOH.
7. Heat at 95° for 1 hr.
8. Cool and add 4 mL of 60% sat NaCl and 1 drop of methyl orange.
9. Extract with three 5-mL portions of hexane - combine hexane portions in test tube.
10. Reduce to 1 mL in N-Evap under a stream of nitrogen.
11. Add 1 mL of 5 ppm Metolachlor in hexane as internal standard - mix well.
12. Place in GC vials.

Note: The optimum conditions for butylation (time and temperature) will be determined. The above values (95° for 1 hr) were used in the previous study.

## APPENDIX V

### Laundrying Instructions for 2,4-D Contaminated Clothing

#### 2,4-D Amine

1. Wash clothing in washing machine separate from the family wash, using as hot of water as possible. Washing in hot water removes more pesticide from the clothing than washing in other water temperatures. Remember . . . the hotter, the better. Avoid cold water washing! Although cold water washing might save energy, cold water temperatures are relatively ineffective in removing pesticides from clothing.
2. Use a heavy duty liquid detergent.

#### 2,4-D Ester

1. Use same instructions as above, except take clothing through 2 complete washings.

These recommendations were obtained from:

Laughlin, J.M., R.E. Gold, C.B. Easley, D.R. Tupy. Laundrying Procedures for Removal of 2,4-D Herbicide from Contaminated Fabrics. Project #114 - North Central Region Pesticide Impact Assessment Group.

NebGuide #HEG81-152, cooperative Extension Service, University of Nebraska.

APPENDIX VI  
URINE COLLECTION INSTRUCTIONS  
FOR FIELD CREW SUPERVISOR

Urine will be collected from each crew member during two consecutive 6-day periods, each period corresponding to one treatment of 2,4-D. Application will be conducted on the second day of each period with urine collection beginning one day prior to the application day. This pre-application day will be designated as Day 1. The application day will be Day 2. Workers should plan to collect urine continuously for the next four days (Days 3, 4, 5, 6). Weather permitting, T-2 pre-application collection day should fall on Day 7. The T-2 application day will be Day 8, and there will be four collection days following (Days 9, 10, 11, 12).

In the case of rain, application dates may be altered. It is very important that the day on which the application occurs is recorded on the "Field Information" sheet. In some cases weather may disrupt the application plan. Workers should continue to collect their urine unless advised otherwise.

For example, workers collect their urine on Day 1. If it rains on Day 2, which is the application day, workers should go ahead and collect their urine on Day 2. The application data will be postponed one day, and the treatment can proceed on Day 3. If this occurs, indicate on the "Field Information" sheet that the application date is on Day 3 rather than Day 2.

Urine collection containers have been labelled for Day 1 through Day 14 for each crew member (2 extra days in case of delays due to weather; more containers will be available if needed). The label on each container consists of three parts. The first part indicates application method (A,

B, C or D). The second part indicates worker number. The third part indicates day.

All containers for each individual worker are bound together and are in consecutive order from Day 1 to Day 14, plus 1 labelled.

Each day of urine collection will consist of the 24-hr period beginning with the worker's second urine sample each morning (after he gets up to stay up) and ends with his first urine sample the next morning. The urine containers will hold 350 mL. If a worker excretes more than this amount during a 24-hr period, he/she should use the additional container for the remainder of the period. It is important that the worker labels the second container with the identical number on the filled container. If a leak occurs, workers may use the additional unnumbered container in place of the leaky container, being sure to label it correctly. The Field Crew Supervisor should check with each worker after 1 or 2 days of urine collection to see if anyone needs additional containers.

The Field Crew Supervisor is responsible for having urine sample transported to a central cooler daily or every 2 days. He must weigh samples, take aliquots from them and see that they are shipped to the laboratory.

Prior to T-2 pre-application day the Supervisor will conduct a meeting in which special procedures (worker hygiene, freshly-laundered clothes, boots, gloves, etc) will be discussed.

## APPENDIX VII

### RESPONSIBILITIES OF FIELD CREW SUPERVISOR

#### I. T-1

##### A. Crew briefing before T-1 Pre-Application Day

- \_\_\_\_\_ 1) Welcome
- \_\_\_\_\_ 2) Slides
- \_\_\_\_\_ 3) Description of study
- \_\_\_\_\_ 4) Questions
- \_\_\_\_\_ 5) Hand out and go over urine collection instructions for workers.
  - \_\_\_\_\_ b) Use 1 container for each 24-hr sample.
  - \_\_\_\_\_ c) A 24-hr period will begin with the worker's second urine excretion each morning (after he gets up to stay up) and ends with his first urine output the next morning.
  - \_\_\_\_\_ d) Additional container is for "overflow" or if a leak occurs. Be sure to label with identical # of 1st container.
  - \_\_\_\_\_ e) Days 13, 14, and unlabelled containers have tape on their handles to readily indicate they are extras.
  - \_\_\_\_\_ f) More containers are available if workers need them.
  - \_\_\_\_\_ g) Keep urine samples cool, using styrofoam cooler and ice.
  - \_\_\_\_\_ h) Bring urine container to work daily.
- \_\_\_\_\_ 6) Arrange workers into work groups and appoint work boss.
- \_\_\_\_\_ 7) Hand out urine containers - Assign worker #'s.
- \_\_\_\_\_ 8) Fill out top of each Worker Information sheet, stressing correct address is necessary to receive \$200 payment.
- \_\_\_\_\_ 9) Obtain shoe sizes. Record this information on Worker Information Sheet. Transfer size information to separate sheet to be returned to Lab.

##### B. T-1 Application Day

- \_\_\_\_\_ 1) Fill out Field Information sheets
- \_\_\_\_\_ 2) Fill out Worker Information sheets
- \_\_\_\_\_ 3) Photograph workers - have sign ready with correct worker # I.D.
- \_\_\_\_\_ 4) Take notes of operation - note unusual occurrences, etc.



## II. T-2

### A. Crew briefing before T-2 Pre-Application Day

- \_\_\_\_\_ 1) Hand out and discuss all points listed on T-2 Worker Instruction sheets.
- \_\_\_\_\_ 2) Hand out boots.
- \_\_\_\_\_ 3) Obtain sizes for leather gloves and rubber gloves - list them on Worker Info sheet.
- \_\_\_\_\_ 4) Hand out detergent and stress laundering instructions.
- \_\_\_\_\_ 5) Stress importance of cleanliness and good personal hygiene.
- \_\_\_\_\_ 6) Weigh workers. List weights on Worker Info sheets.

### B. T-2 Application Day

- \_\_\_\_\_ 1) Fill out Field Information sheets.
- \_\_\_\_\_ 2) Fill out Worker Information sheets.
- \_\_\_\_\_ 3) Check that proper clothing is worn.
- \_\_\_\_\_ 4) Hand out leather gloves and rubber gloves.
- \_\_\_\_\_ 5) Check that equipment is proper, and lids are tight.
- \_\_\_\_\_ 6) Photograph workers, with correct worker # I.D.
- \_\_\_\_\_ 7) Take notes of operation - note unusual occurrences, etc.
- \_\_\_\_\_ 8) Be sure hand washing facilities are available (paper towels can be strung on clothesline, water, worksoap).
- \_\_\_\_\_ 9) Enforce hand washing and special instructions.
- \_\_\_\_\_ 10) Interview workers at end of work day.
- \_\_\_\_\_ 11) Collect leather gloves - place in bags to be returned to workers after last T-2 urine collection day.
- \_\_\_\_\_ 12) Hand out cotton work gloves.

### III. Handling of urine samples

- \_\_\_\_\_ A. Daily pickup and storage
- \_\_\_\_\_ B. Central cooler
- \_\_\_\_\_ D. Keep record of samples received
- \_\_\_\_\_ D. Locate work area for transfer and weighing
- \_\_\_\_\_ E. Weigh and record sample weights
- \_\_\_\_\_ F. Transfer aliquots to 60-ml bottles and label with pre-typed stick on labels
- \_\_\_\_\_ G. In case "overflow" containers are used, label both bottles with same number, identifying the first with an "a" and the second with a "b."  
Example: Al-1a, Al-1b
- \_\_\_\_\_ H. Prepare field spikes
- \_\_\_\_\_ I. Ship samples to Alzheimer Lab

## APPENDIX VIII

### URINE COLLECTION INSTRUCTIONS

#### FOR WORKERS

1. In this research study, 100% of your urine will be collected for at least 12 days. (Every drop is needed.) You will apply herbicide on 2 different days during this time.
2. You will collect your urine in one container each day. The day begins with your second urine sample each morning (after you get up to stay up) and ends with your first urine sample the next morning.
3. Urine collection will begin one day prior to the application day. The 1st pre-application day will be designated as Day 1. The application day will be Day 2. You should collect your urine continuously through Day 12. Weather permitting, the 2nd pre-application collection day should fall on Day 7. The 2nd application day will be Day 8.
4. Keep your samples cool (refrigerated, if possible) until they are transported to a central cooler.
5. To qualify for the \$200 payment you must:
  - a) Supply us with total urine samples for at least 12 days (more, if application days are delayed due to weather conditions).
  - b) Fill out Daily Record sheet each day and turn in with final urine sample.
  - c) Follow all instructions given.
6. If some accident or uncontrollable emergency arises, be sure to note when this occurred and approximately how much urine was lost or not saved on the Daily Record sheet. If a problem arises during urine collection, be truthful. We may still be able to use your urine if we know the details. Chemical tests will indicate whether there are urine collection inconsistencies.
7. Reminder: On the day of application, please try not to handle your urine containers any more than necessary, especially with hands or clothing that have contacted the herbicide.

You will receive:

- a) 14 plastic urine containers

They are labelled with your Worker # and are in consecutive order for Day 1 through Day 14. (Days 13 and 14 have been included in case an application day is delayed due to weather conditions.)

- b) unlabelled plastic urine container

This is to be used in case a leak occurs or if you excrete more urine during a 24-hr period than an single container will hold. It is important that you label the 2nd container with the identical # as is on the leaky or filled container. Let crew supervisor know if you need additional containers.

## APPENDIX IX

### T-2 WORKER INSTRUCTIONS

1. Items you will receive:
  - a) boots
  - b) leather gloves
  - c) laundering instructions
  - d) heavy duty liquid detergent
  - e) rubber gloves
  - f) cotton gloves
2. Beginning the morning before the 2nd 2,4-D application day:
  - a) wear freshly laundered clothing (see instructions below)
  - b) wear new boots
  - c) wear new leather gloves if you are doing work in which gloves are needed.
3. On 2nd application day:
  - a) wear freshly laundered long sleeve shirts and pants, both cotton.
  - b) wear new boots.
  - c) wear rubber gloves, when mixing, filling your application device, or unplugging nozzles.
  - d) wear leather gloves during herbicide application.
  - f) wash hands before rest stops (before using urine containers, eating or using tobacco).
  - g) bathe and change into clean clothing as soon as possible after work.
  - h) abide by all instructions given by field crew supervisor to help minimize exposure.
4. All clothing worn during the urine-collection days following the 2nd application day must also have been laundered according to instructions. You will receive a new pair of cotton work gloves to be worn during this time if you engage in activities where gloves are needed. Do not wear gloves previously used in herbicide application.

#### Laundering Pesticide Contaminated Clothing

The following are laundering instructions for clothing contaminated with Weedone 170 or Tordon 101R.

1. Wash clothing in washing machine separate from the family wash, using as hot of water as possible. Washing in hot water removes more pesticide from the clothing than washing in other water temperatures. Remember. . the hotter, the better. Avoid cold water washing! Although cold water washing might save energy, cold water temperatures are relatively ineffective in removing pesticides from clothing.
2. Use a heavy duty liquid detergent. Detergent will be provided for you to take home.

## APPENDIX X

NAME \_\_\_\_\_

WORKER # \_\_\_\_\_

DAILY RECORD SHEET  
(FILL OUT DAILY)

| URINE<br>COLLECTION<br>DAY | DAY OF<br>WEEK | DATE  | DID YOU LOSE<br>ANY URINE?<br>(CIRCLE ONE) | IF YES,<br>HOW MUCH?<br>( $\frac{1}{2}$ CUP, CUP) | DID YOU PERSPIRE TODAY?<br>INDICATE HOW MUCH |
|----------------------------|----------------|-------|--|---|--|
| DAY 1                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 2                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 3                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 4                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 5                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 6                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 7                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 8                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 9                      | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 10                     | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 11                     | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 12                     | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 13                     | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |
| DAY 14                     | _____          | _____ | YES NO                                     | _____   | HEAVY MEDIUM LIGHT                           |

Answer the following questions at end of study:

- Did you apply any pesticide on your garden or land during this study?

YES NO

If yes, what pesticide did you use? \_\_\_\_\_

# APPENDIX XI

## WORKER INFORMATION (To be filled out by Field Crew Supervisor)

NAME \_\_\_\_\_ WORKER # \_\_\_\_\_  
 ADDRESS \_\_\_\_\_ EMPLOYER \_\_\_\_\_  
 \_\_\_\_\_ APPLICATION METHOD \_\_\_\_\_  
 PHONE \_\_\_\_\_ HERBICIDE \_\_\_\_\_  
 SEX \_\_\_\_\_ AGE \_\_\_\_\_ SHOE SIZE \_\_\_\_\_  
 HEIGHT \_\_\_\_\_ WEIGHT \_\_\_\_\_

How long has it been since you've worked with a phenoxy herbicide? \_\_\_\_\_  
 Have you been exposed to 2,4-D in any manner within the last 2 weeks? YES NO  
 If yes, describe: \_\_\_\_\_

|                       | T-1   | T-2  |
|-----------------------|---|--|
| PHOTO TAKEN:          | _____   | _____  |
| SHIRT:                | LONG SL _____ COTTON _____<br>SHORT SL _____ KNIT _____<br>NO SHIRT _____ POLY _____  | IS WORKER DRESSED ACCORDING TO<br>INSTRUCTIONS? YES NO<br>IF NO, EXPLAIN _____ |
| PANTS:                | LONG _____ DENIM _____<br>SHORT _____ CORDUROY _____<br>OVERALL _____ POLYESTER _____ | ARE CLOTHES FRESHLY LAUNDERED?<br>YES NO                                       |
| SHOES:                | LOW _____ LEATHER _____<br>HIGH _____ RUBBER _____<br>FABRIC _____                    |  |
| GLOVES:               | RUBBER _____<br>COTTON _____<br>LEATHER _____   |  |
| HAT:                  | NO YES TYPE _____   | NO YES TYPE _____  |
| GLASSES:              | NO YES  | NO YES   |
| GOGGLES:              | NO YES  | NO YES   |
| DISPOSABLE COVERALLS: | NO YES  | NO YES   |
| OTHER:                | _____<br>_____  | _____<br>_____   |

### APPLICATION ACTIVITIES

|   |                                  |                                  |
|---|----------------------------------|----------------------------------|
| DID YOU GET ANY CON-<br>CENTRATE ON YOURSELF? | BARESKIN: NO YES<br>WHERE? _____ | BARESKIN: NO YES<br>WHERE? _____ |
|   | CLOTHING: NO YES<br>WHERE? _____ | CLOTHING: NO YES<br>WHERE? _____ |

DID YOU PERSPIRE MUCH? HEAVY MEDIUM LIGHT      HEAVY MEDIUM LIGHT



# APPENDIX XII

## FIELD INFORMATION

(This sheet to be filled out during each application day  
by Field Crew Supervisor)

|                                     | <u>T-1</u> | <u>T-2</u> |
|-------------------------------------|------------|------------|
| Application date                    | _____      | _____      |
| Location                            | _____      | _____      |
| Application method                  | _____      | _____      |
| Compound                            | _____      | _____      |
| Formulation                         | _____      | _____      |
| Concentration<br>(was water added?) | _____      | _____      |
| If yes, how much?                   | _____      | _____      |
| # acres treated                     | _____      | _____      |
| Vol./Load                           | _____      | _____      |
| Time application began              | _____      | _____      |
| Time application ended              | _____      | _____      |
| Day of worker urine<br>collection   | _____      | _____      |

### Record weather information at 2-hr intervals

|                   |       |       |       |       |       |       |       |
|-------------------|-------|-------|-------|-------|-------|-------|-------|
| Time              | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| Temperature       | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| Wind direction    | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| Wind speed        | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| Sun condition     | _____ | _____ | _____ | _____ | _____ | _____ | _____ |
| Relative humidity | _____ | _____ | _____ | _____ | _____ | _____ | _____ |

Weather notes:

Exposure notes:

Unusual occurrences:

APPENDIX XIII

CONSENT FORM

I, \_\_\_\_\_, being at least twenty-one (21) years old and an employee of \_\_\_\_\_, hereby give my voluntary and informed consent to participate in the Forest Service study of the application of 2,4-D.

For purposes of this study, I have agreed to act as a(n) \_\_\_\_\_ (injection applicator or, backpack sprayer of 2,4-D).

I understand I will not be asked to perform any work function which is not considered normal safe application procedures for these methods of application.

I am aware that, on the basis of existing scientific information, the Forest Service and the forest industry believe that the proper spraying of 2,4-D in the forest, or the spraying of the 2,4-D in the course of this study, will not give rise to any unreasonable health hazard. I also understand that EPA concluded from a review of available scientific data that the continued use of 2,4-D poses no imminent hazard or unreasonable adverse effect when used according to label precautions and directions.

However, I am aware that the EPA has asked the registrants of 2,4-D to initiate new toxicology tests in order to establish no observable effect levels and to provide more conclusive data on the tumor-causing potential of 2,4-D.

I understand that I may withdraw from this study at any time.

I understand that, at any time after the study is completed, I will have access to the results of any tests conducted on samples I have provided.

I freely and voluntarily consent to participate in this study and I consent to public release and all other use of all personal information and individual data collected from me in connection with this study, whether presented in individual or summary fashion. I understand that this information will not be identified by my name.

\_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Employee's Signature)

I was present during the explanation mentioned above and the volunteer's opportunity to ask questions, and I hereby witness (his) (her) consent to participate in this study.

\_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Witness' Signature)

## APPENDIX XIV

### Processing of Urine Samples

1. Place a disposable cup and 60-ml square polyethylene bottle into holding board.
2. Weigh full urine container and record weight in notebook.
3. Agitate contents of urine container by shaking back and forth four times.
4. Pull capped portion of container out, to make pouring easier. Remove cap.
5. Fill cup about 1/3 full. Transfer this into bottle.
6. Pour any remaining urine back into urine container.
7. Attach matching stick-on label to bottle. Screw its cap on tightly.
8. Then. . .put cap back on urine container. I might be wise to mark the container in some manner (x on the car or cap) so it is readily apparent that an aliquot has been removed from that container.
9. Urine containers will remain in storage until notification is received that the corresponding aliquots have been logged in at Alzheimer Lab.
10. In case "overflow" containers are used, label both bottles with same number, identifying the first with an "a" and the second with a "b."  
Example: Al-1a, Al-1b
11. Go to Field Spike section following processing of urine samples for T-1 Pre-Application Day.

## APPENDIX XV

### Preparation of Field Fortified Samples

After processing the T-1 pre-application day urine, the Field Crew Supervisor will take additional aliquots from this urine and fortify it with known amounts of 2,4-D acid. These fortified samples will be subject to all the same conditions as the unfortified samples. Their purpose will be to serve as bench-marks in case irregularities occur in shipment, storage conditions, or analytical time.

Two 2,4-D stock solutions, labelled RFD (1.0 ppm) and BLUE (5.0 ppm), will be provided at each cooler storage location. At each location 30 aliquots will be drawn from the fullest pre-application urine container. Fifteen will be spiked with RED and 15 with BLUE. Three of each concentration will accompany each group of samples as they are transported to the Altheimer Lab.

#### Instructions:

(These instructions are to be followed after all aliquots have been taken from urine containers for regular samples.)

- 1) Set out thirty 60-ml square polyethelene bottles.
- 2) Attach pre-typed stick-on labels (these are in the "Spike Labels" envelope). The label contains a letter indicating the application method and a number indicating the spiking location such that spikes are labelled in a manner similar to the unfortified samples.
- 3) Choose fullest pre-application urine container. (The container must have at least 1600 ml for the thirty aliquots. If none of the samples contain this much, 2 may be poured together into a new container and mixed thoroughly. It is necessary to combine 2 samples, record amounts of each mixed together.

- 4) Record location where this procedure is being carried out, date and worker # of urine sample used, on Field Fortified Samples Record Sheet.
- 5) Add 5-ml of RED to bottles 1 through 15 using an Oxford Marco Pipet and one pipet tip. Allow spiking solution to fill pipet tip slowly. Touch tip to rim of spiking solution bottle before emptying it into the sample bottle.
- 6) Add 5-ml of BLUE to bottles 16 through 30 using a second pipet tip.
- 7) After spiking solutions have been added to all bottles, place first bottle on scale. Push tare button and observe that display reads 0.0.
- 8) Add approximately 50 g of urine to bottle, recording exact weight on Record Sheet. Repeat steps 7 and 8 for all bottles.
- 9) Place 3 bottles of each concentration in ziploc bag. (Total of 6 bottles). Label with spiking location, and date of spiking. File card may be used for this. Add date of shipment to this label when samples are picked up. (Also include original spiking solution bottles in bag for 1st shipment.)
- 10) Store in appropriate part of cooler so that these packets can be shipped with samples each time they are transported to the Alzheimer Lab.

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